Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
The State of Competition in the Communications Marketplace	)	GN Docket No. 20-60
	)	

To: Chief, Office of Economics and Analytics

COMMENTS OF
THE WIRELESS INTERNET SERVICE PROVIDERS ASSOCIATION

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April 27, 2020

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Summary

The Wireless Internet Service Providers Association ("WISPA") represents the interests of the fixed wireless broadband industry, whose members are predominantly small providers with 10 or fewer employees that offer affordable high-speed fixed wireless broadband service, voice, and often, video to an estimated 6 million residential and business consumers, first responder and health organizations, and educational institutions – entire communities often in underserved and rural areas where other providers choose not to invest. Fixed wireless technology continues to be the fastest growing technology for deploying high-speed broadband in the United States and globally. Fixed wireless technology is also capable of providing up to Gigabit speeds to residences and multiple tenant environments ("MTEs") at a fraction of the capital cost of fiber and cable.

WISPA's members, who pioneered fixed wireless technology more than 20 years ago, are often the first and only terrestrial provider to serve rural and other unserved areas that lack access to broadband services. During the COVID-19 public health crisis when much of the country's population remains under stay-at-home orders, access to broadband has become an essential resource for telemedicine, news, information, education, work, entertainment and staying in touch with family and friends. Unserved and underserved communities without broadband access are at a severe risk of isolation and falling further behind as part of the digital economy. WISPA's members are taking extraordinary measures to close that gap, working around the clock to fill broadband orders and upgrade their networks, providing free broadband service to families with children so that children can continue with their school assignments, and providing free Wi-Fi in their communities, while trying to keep their employees and contractors safe. Bridging the digital divide must remain a top priority for providers of all sizes and government at

all levels. WISPA identifies the laws, regulations, regulatory practices and policies that serve as market barriers to entry, growth and competition for fixed wireless providers, especially small providers. These include longstanding, but outdated, rules that effectively restrict access to MTEs for new entrants and fixed wireless technology, prohibit the types of equipment necessary to provide fixed wireless and 5G technology that can be installed on consumer premises, and government subsidized overbuilding. They also include the absence of accurate, timely and more granular data for measuring broadband deployment in ways that do not overburden smaller providers and reflect the technology used, and abrupt and material changes in regulations that impact small providers' access to spectrum.

The elimination or modification of rules and policies that create barriers to entry and growth are important to promote competition and create a communications marketplace for affordable broadband access that provides choice for all consumers and will include everyone in the new digital economy.

WISPA is pleased that the Commission is proceeding with its CBRS auction and making unlicensed spectrum in the 6 GHz band – and hopefully the 5.9 GHz band as well – to enable WISPs to better serve their communities. As consumer demand for broadband increases, so too do the needs of providers that offer those services, especially in rural areas. The subsidies provided by the Connect America Fund and the upcoming Rural Digital Opportunity Fund Phase I auction offer significant opportunities to accelerate the deployment of faster, more robust broadband to rural areas lacking adequate service.

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The Wireless Internet Service Providers Association ("WISPA"),[1] pursuant to Sections 1.415 and 1.419 of the Commission's Rules, hereby comments on certain aspects of the Office of Economics and Analytics' ("OEA") Public Notice in the above-captioned proceeding.[2]

[1] WISPA is a trade organization that represents the interests of hundreds of small fixed-wireless broadband providers ("WISPs") that deliver internet connectivity services to more than four million consumers, businesses, first responders and community institutions in areas of the country where other service providers decline to invest. Most WISPs are small businesses with 10 or fewer employees. To provide their services, WISPs use unlicensed, lightly-licensed and licensed spectrum in low, mid-band, and high-band frequencies, predominantly in rural, unserved, and underserved areas. In many areas, WISPs provide the only terrestrial source of fixed broadband access. In areas with other broadband options, WISPs provide a local-access alternative that benefits customers by fostering competition, lowering costs and improving features.

[2] *See Office of Economics and Analytics Seeks Comment on the State of Competition in the Communications Marketplace*, Public Notice, DA 20-199 (rel. Feb. 27, 2020) ("*Public Notice*"). WISPA commented in the proceeding leading to adoption of the 2018 Communications Market Report. *See* Comments of the WISPA, GN Docket No. 18-31 (filed Aug. 17, 2018) ("WISPA 2018 CMR Comments"). WISPA also has regularly participated in proceedings concerning the state of deployment of advanced telecommunications service under Section 706 of the Telecommunications Act. *See, e.g.*, WISPA Comments, GN Docket No. 19-285 (filed Dec. 9, 2019); WISPA Comments, GN Docket No. 18-238 (filed Sept. 17, 2018); WISPA Comments, GN Docket No. 17-199 (filed Sept. 21, 2017); WISPA Comments, GN Docket No. 16-245 (filed Sept. 6, 2016).

Discussion

I. STATE OF THE FIXED WIRELESS INDUSTRY

The use of fixed wireless technology to bring affordable high-speed broadband service to unserved and underserved communities has increased over the past few years, driven by the ability of fixed wireless internet service providers ("WISPs") to deploy broadband service in a very short time frame and at a fraction of the capital cost of cable and fiber to the premises ("FTTP").[3] Significantly, fixed wireless technology is being used to serve not only residential and commercial customers, but also educational institutions, public safety and health facilities, factories, farms – entire communities.

As a result, WISPA's members who pioneered fixed wireless technology more than 20 years ago have been joined by traditional cable and telecommunications operators – large and small – that are using fixed wireless access ("FWA") to supplement and complement their wired technology. "Broadband providers of all sizes and stripes are now adding FWA to their portfolio to serve many different types of geographic markets – rural, suburban, and urban. Improving FWA technology makes the application more attractive, even rivaling wireline broadband

[3] *See* Finley Engineering, *Understanding The Expanding Fixed Wireless Broadband Opportunity*, FINLEY USA (July 2019) at 1 ("FWA draws interest and attention because of relatively favorable network economics, when compared to more expensive wireline options.") ("Finley Engineering Report"). A copy of the Finley Engineering Report is attached hereto as Appendix A. *See also* Maravedis Wireless Infrastructure Analysis, *5G Fixed Wireless Gigabit Services Today: An Industry Overview*, MARAVEDIS LLC (Nov. 2016) ("Maravedis 5G Analysis") at 3 ("[S]ince the cost and speed of 5G FWA infrastructure deployment easily beats the cost and time required to extend fiber-optic cables straight to the premises (fiber-to-the-premises, FTTP, or fiber-to-the-home, FTTH), 5G FWA allows fiber networks to easily be deployed and scaled without compromising broadband speed or reliability.") A copy of the Maravedis 5G Analysis is attached hereto as Appendix B. *See also* The BWA Industry Report, *Ready for Takeoff: Broadband Wireless Access Providers Prepare to Soar with Fixed Wireless*, THE CARMEL GROUP (2017) ("The Carmel Report") at 5.

capabilities in some instances."[4] Moreover, the United States and other North American countries consider FWA "as a separate top-level category [for use of 5G], in part due to its prominence as an early 5G deployment case *and its potential to help close the digital divide.* Instead of laying fiber to customers' premises — which could entail laying miles and miles of fiber to sparsely populated remote regions, sometimes across treacherous terrain — FWA leverages wireless communication for 'last-mile' connectivity."[5] This is further illustrated by the rules the Commission recently adopted for the Rural Digital Opportunity Fund ("RDOF"), which illustrate a "preference for higher speeds, higher usage allowances, and low latency."[6] The Commission elaborated by stating that "our goal to close the digital divide is balanced against our goal to support the deployment of future-proof networks by this auction."[7]

In 2017, The Carmel Report identified seven growth drivers that are lifting the fixed wireless broadband industry.[8] Today, these growth drivers are still very relevant and continue to be major factors in the growth of fixed wireless technology. WISPA members recently reported

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[4] Finley Engineering Report at 1. Traditional providers include Verizon, T-Mobile, Pioneer, US Cellular, and MidContinent that are using FWA. *Id.* at 2-4. *See also* Office of Science and Technology Policy, Executive Office of the President of the United States, *Emerging Technologies And Their Expected Impact On Non-Federal Spectrum Demand* (May 2019) ("White House Emerging Technologies Report") at 35.

[5] White House Emerging Technologies Report at 35 (citations omitted) (emphasis added).

[6] *Rural Digital Opportunity Fund*, Report and Order, WC Docket Nos. 19-126 and 10-90, FCC 20-5, 35 FCC Rcd 686, 705 (¶38) (2020) ("*RDOF Order*").

[7] *Id.* at 696 (¶21).

[8] The Carmel Report at 4 (The drivers are: "1) The economics of wireless technology enable network deployments at a fraction of the cost of wireline; 2) The economics of unlicensed spectrum and trends in spectrum regulation are favorable to fixed wireless; 3) Consumer demands for broadband connectivity and associated applications, especially video, are surging at an exponential rate; 4) Global standards-based technologies, such as LTE, and a growing equipment ecosystem are being leveraged for fixed wireless uses; 5) Industry consolidation and a healthy funding environment from private and government sources are driving investment; 6) New entrants and hybrid networks are validating the business model; and 7) New markets in urban areas and categories such as home automation, home security, and the Internet of Things (IoT) present further opportunities for fixed wireless growth.").

that Driver #3, increased consumer demand, has increased more than 35 percent during the current COVID-19 pandemic.[9]

A. WISPs Are Meeting The Challenges Of Increased Demand During The COVID-19 Pandemic

In light of the COVID-19 crisis and stay-at-home orders from Federal and State authorities, WISPA's members report unprecedented demand for fixed broadband, especially in residences where consumers are clustered and are accessing online services and applications to learn and work. The urgent nature of this crisis means that fixed broadband service must be deployed and upgraded immediately. Fixed wireless technology is the only technology that can meet immediate deployment demands for reliable and affordable high-speed, low-latency services in rural and remote areas where wireline service is not available.[10] WISPA appreciates the Commission's recent grant of Special Temporary Authority ("STA") so that WISPs can access 45 megahertz of spectrum in the 5850-5925 MHz band to help meet the demand surge.[11]

A recent survey of WISPA members' response to this public health crisis illustrates that overall, WISPs appear to be weathering the storm relatively well, with the overwhelming majority of them growing business even in light of new use dynamics, workforce bandwidth challenges, potential equipment supply chain shortfalls and the practical concerns that the

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[9] Survey: WISPs Responding to COVID-19 (Apr. 3, 2020) *available at* https://www.wispa.org/survey_-_wisps_responding_to_c.php ("WISPA COVID-19 Survey").

[10] Broadband delivered via a mobile device is not a viable substitute for fixed wireless broadband services, in cost, speed or reliability. *See Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion*, 2019 Broadband Deployment Report, GN Docket No. 18-238, 34 FCC Rcd 3857, 3861-62 (¶11) (2019). Although broadband service via satellite at 25 Mbps/3 Mbps speeds is readily available "to nearly all of the population," *Id.* at 3870 (¶28). The laws of physics constrain the ability of existing satellites to provide reliable, low-latency broadband.

[11] *See* Email from Keith Harper, FCC, to Stephen E. Coran (Mar. 27, 2020) (granting STA to 33 WISPs); *FCC Grants Wireless ISPs Temporary Access to Spectrum in 5.9 GHz Band to Meet Increase in Rural Demand During Pandemic*, News Release (Mar. 27, 2020). Many others have requested and obtained STA through Form 601 applications.

pandemic poses to keeping everyday operations running safely for all.[12] In sum, WISPA's members are taking extraordinary measures to meet surging demand for fixed broadband services, including working around the clock, continuing to perform in-home installations and making service calls (but with caution given safety concerns for employees and contractors), and hiring more personnel to ensure continued and reliable broadband service.[13] Several WISPs have expressed a need for personal protection equipment.[14] Some WISPs also are providing free service to families with school-age children that lack internet service to ensure children can access public school resources from home during school closures, and others are donating Wi-Fi equipment and technical assistance to communities with limited or no Internet.[15] Here are survey highlights:

- **WISPs are seeing an average increase of about 36% in traffic**. Many have planned for this, but others are working to add capacity, too.
- **83% of WISPs are adding new subscribers**, with this business being **33% above normal**. **22% are hiring new staff** to meet the new growth and/or service issues.
- **87% of WISPs are doing in-home and/or in-office service calls**, with these calls at **18% above normal**.
- **87% have the equipment to manage new subscribers**, yet some are concerned about eventual equipment shortfalls.
- **48% of WISPs are offering free Wi-Fi or other connectivity** to customers or public institutions, and **40% of WISPs are working with other communications providers** to serve their local communities.
- **12% of service calls have been canceled** due to health concerns.[16]

WISPA, in support of its members during this crisis, is working overtime to secure temporary use of additional spectrum to help ease operational challenges.[17]

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[12] WISPA COVID-19 Survey.
[13] *Id.*
[14] *Id.*
[15] *Id.*
[16] *Id.* (emphasis in original).
[17] For example, WISPA has held webinars on the CARES Act regarding access to government loans for small businesses, and supported members regarding STA for use of additional spectrum to meet unprecedented consumer need for broadband and Wi-Fi services, or relief from certain regulatory requirements during this national health crisis.

B. Access To Unlicensed And Licensed Spectrum Is Critical To The Growth Of Fixed Wireless Providers And Deployment Of 5G Technology

One of the biggest challenges WISPs face is access to both licensed and unlicensed spectrum. WISPs are building high-speed broadband networks at a faster rate, especially in high-cost rural areas, using a combination of licensed spectrum, unlicensed spectrum and shared access spectrum.

In the United States, "5G FWA has emerged as the first real offering of commercial 5G services."[18] Having access to 5G technology is important to WISPs to deliver upgraded services to their customers and to remain competitive against larger providers. Fixed wireless providers are using a combination of technology, i.e., hybrid models that include fixed wireless with fiber and/or millimeter wave ("mmW") technology to provide "fiber-like 5G" Gigabit high-speed broadband.[19] Use of licensed and unlicensed mmW frequencies is the "most cost-effective" means to deploy fixed wireless services in both single family homes and MTEs.[20] A significant number of trials and deployments prove that FWA can deliver Gigabit speeds."[21] For example, WISPA members like W.A.T.C.H. TV Company ("Watch"), serving portions of rural Ohio, Indiana, Illinois and Kentucky, and AeroNet Wireless Broadband ("AeroNet") in Puerto Rico are

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[18] Maravedis 5G Analysis at 19.
[19] *Id.* at 3. "Using unlicensed or lightly-licensed mmWave frequencies, such as the 60 GHz V-Band or 70/80 GHz E-Band, is therefore a cost-effective choice for deploying fiber-like 5G FWA. Commercial mmWave radios are capable of operating in a point-to-point (PtP) or point-to-multipoint (PtMP) topology to deliver gigabit broadband to businesses, Multiple Dwelling Units (MDUs), and single-family homes and are currently available for deploying 5G FWA." *Id.*
[20] *Id*. at 4.
[21] *Id.* at 3 ("In addition to the cost, time, and scalability advantages of 5G FWA (as opposed to FTTH), a multitude of 5G trials and deployments have validated the technology for 5G FWA.").

deploying Gigabit networks.[22] WISPs also are partnering with electric co-ops in rural areas[23] and with technology companies such as Microsoft and Facebook to increase the availability of affordable broadband service in rural areas.[24]

C. WISPs Also Are Providing Competitive Broadband And Wi-Fi Services To MTEs Using Various Spectrum Bands And 5G Technology

While the vast majority of WISPA's members continue to make great strides in bringing affordable high-speed broadband to predominantly unserved and underserved rural areas, some also are providing the same cost-effective and deployment-efficient broadband service, as well as Wi-Fi services, to MTEs in urban and suburban areas.[25] Some WISPs are also using mmW spectrum to bring high-quality, affordable broadband service to residential and commercial tenants in MTEs.[26] As discussed in more detail below, deployment in MTEs can be very cost-effective for both tenants and building owners because the investment to deploy fixed wireless

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[22] Comments of WISPA, GN Docket No. 19-126 (filed Mar. 27, 2020) at 13 (documenting innovative deployment of 5G by WISPs). Watch plans to provide fixed wireless services "at Gigabit speeds in areas where it intends to seek RDOF funding [and] to utilize Terragraph-based solutions to offer the same speed in areas where it did not acquire licensed 37 GHz spectrum." *Id*. AeroNet "has launched a Terragraph pilot program using 60 GHz equipment to offer the people of Puerto Rico a high-gigabit internet experience while bringing innovative technology to a historical site in Puerto Rico." *Id.*

[23] For example, in Stillwater, Oklahoma, WISPA member ProValue.net and Co-op Central Electric have forged an innovative partnership and are "deploying robust infrastructure to ensure that rural Americans have service on par with their urban counterparts." *Claude's Blog: WISPs and Electric Coops - Strong Community Broadband Partners* (Mar. 2020) *available at* http://wispa.org/news_manager.php?page=21565 ("ProValue and Central have an innovative infrastructure-sharing partnership, cross-marketing, and billing arrangement that allows Central's members to receive internet access from ProValue and have both services on the same bill.").

[24] Finley Engineering Report at 3-4. Microsoft's Airband program includes a partnership with at least eight WISPs in 16 states to provide 25/3 Mbps service using FWA. *Id*. at 4. AeroNet is trialing Facebook's Terragraph technology in San Juan, Puerto Rico. *See Puerto Rico's AeroNet to test Facebook's Terragraph for high-speed broadband*, Light Reading (Feb. 19, 2020) *available at* https://www.lightreading.com/puerto-ricos-aeronet-to-test-facebooks-terragraph-for-high-speed-broadband-/d/d-id/757591.

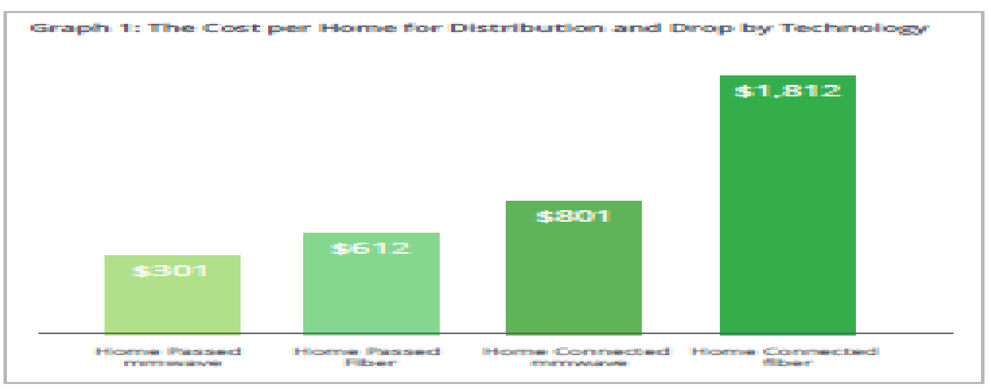
[25] *See id.* at 3-4; *see also* Comments of WISPA, GN Docket No. 17-142 (filed Aug. 30, 2019) (citing to Member MTE Survey) at 4 ("WISPA MTE Comments").

[26] Reply Comments of WISPA, GN Docket No. 17-142 (filed Sept. 30, 2019) at 8 (citing to Common Networks, an experienced WISP that deploys broadband at 1/50th of the cost of fiber technology) ("WISPA MTE Reply Comments"). Common's antennas located on MTE rooftops not only facilitate service to tenants of an MTE, but also service to consumers in surrounding communities. *Id.*

technology in existing and new building structures is considerably less than fiber and can be deployed more efficiently.

D. Fixed Wireless Broadband Technology Continues To Be Deployed At Low Overall Capital Costs And Is Cost-Effective

One of the primary advantages fixed wireless technology enjoys over wireline technology is that FWA can be deployed at a fraction of the cost of fiber and cable.[27] This cost differential is also true when the cost per home passed or connected[28] for fiber is compared with using fixed wireless technology.[29] It is no secret that the number of homes "connected with fiber is lagging well behind the number of homes passed/marketed (not dropped)"[30] because it is more expensive to deploy fiber to a customer's home than it is to deploy fixed wireless: Compare $301 per Home Passed using mmW with $612 per Home Passed using fiber.[31] The same is true when the cost to deploy fixed wireless using mmW technology is compared with fiber: Compare $801 per Home Connected using mmW with $1,812 per Home Connected using fiber – more than a 125 percent increase.[32]



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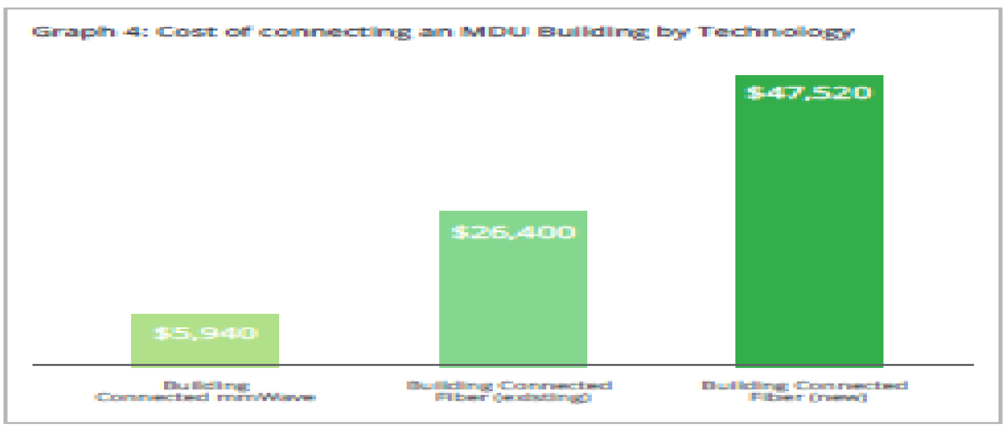
[27] *Communications Marketplace Report*, Report, 33 FCC Rcd 12558, 12647 (¶177 n.560) (2018).
[28] "Homes Passed" is the potential number of homes that a service provider has capability to connect to a network in a particular service area. This definition excludes homes that cannot be connected without further installation of substantial equipment. "Homes Connected" are homes that already subscribe to a network or can be turned into subscribers without further installation of equipment.
[29] Maravedis 5G Analysis at 23.
[30] *Id.*
[31] *Id.* (Graph 1).
[32] *Id.*

The cost to deploy fixed wireless technology compared to fiber for MTEs or Multiple Dwelling Units ("MDUs") is even more dramatic. MDUs "represent about 30% of the total residential market for [Gigabit to the Home]. But on the other hand, MDUs are difficult and complex to reach with fiber."[33] The cost to deploy fixed broadband to an existing structure compared to a new structure is a major factor: Compare the Cost of Connecting an MDU Building By Technology - $5,940 with mmW; $26,400 with Fiber for existing building; and $47,520 with Fiber for new building.[34]



II. FIXED WIRELESS PROVIDERS, ESPECIALLY SMALL PROVIDERS, CONTINUE TO FACE NUMEROUS BARRIERS TO ENTRY AND GROWTH

The *Public Notice* seeks comment on whether "laws, regulations, regulatory practices, or demonstrated marketplace practices pose a barrier to facilities-based competitive entry into the marketplace for the provision of fixed services, or to the competitive expansion of existing facilities-based service providers."[35] It also asks whether and to what extent such barriers affect "entrepreneurs and small businesses."[36]

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[33] *Id.* at 26.
[34] *Id.* at 28 (Graph 4).
[35] *Public Notice*, *supra* note 2, at 3, Sec. III Competition and Deployment in Fixed Services.
[36] *Id.*

Federal agencies and policy makers have acknowledged that the WISP model of broadband deployment is a powerful way to deploy affordable high-speed broadband in a cost-effective and expedited manner.[37] WISPA appreciates positive regulatory measures that the Commission has taken to enable WISPs to do even more to bridge the digital divide, such as opening up the Citizens Broadband Radio Service ("CBRS") band for flexible, shared use; eliminating restrictions to enable more robust use of the Educational Broadband Service band; proposing access to unlicensed spectrum in the 5.9 GHz and 6 GHz bands to enable outdoor use; working to update OTARD rules to better enable WISP access to state, local and HOA infrastructure; and establishing the $20 billion RDOF program through technology-neutral, Connect America Fund ("CAF") Phase II-like reverse auctions. The CAF Phase II auction process illustrates the effectiveness of Commission rules and processes that increased opportunities for small providers to participate and win support for broadband deployment in rural areas.[38] WISPA also observes that its members that are receiving CAF Phase II support are attracting investment and strategic capital that can be used to expedite CAF deployment, expand networks and provide management experience. The ability to leverage CAF support (and any other subsidy) for private investment will accelerate the deployment of cost-effective broadband and increase the competitive impact of WISPs as they expand into new markets.

The recent action by the Commission to make available 1,200 megahertz of spectrum in the 6 GHz band for unlicensed use, including 850 megahertz for standard power use subject to

[37] *See* White House Emerging Technologies Report, *supra* note 4, at 35 (recognizing fixed wireless technology "as a separate top-level category [for use of 5G], in part due to its prominence as an early 5G deployment case *and its potential to help close the digital divide"); see also* Finley Report, *supra* note 3, at 4 ("The future looks bright for FWA, as policymakers increasingly see the technology as part of the answer to address the digital divide.").

[38] *See Fixed Wireless ISPs Wins Big in CAF II Auction*, Inside Towers, Aug. 30, 2018 *available at* https://insidetowers.com/cell-tower-news-fixed-wireless-isps-win-big-caf-ii-auction/.

automated frequency coordination ("AFC") will make a major difference to rural communities.[39] "The spectrum will allow small rural innovators such as WISPs to bring exciting new broadband services to more rural Americans. When combined with other spectrum such as mmW, fixed 5G can be brought out to the hinterlands. . . . And, the cost-effectiveness of fixed wireless – which can be deployed almost overnight at about 15% of the cost of fiber or other wired technology – means this new spectrum will soon play a major role in reducing the digital divide."[40] Still, challenges remain.

A. Last Minute And Unexpected Material Changes In Regulations And Policies Impose Increased Uncertainty That Hampers And Constrains Network Improvements, Access To Capital And Competition

It has long been recognized that regulatory uncertainty hampers investment, access to capital and growth.[41] WISPA understands first-hand the negative and long-term impact of unexpected and untimely proposed or adopted regulatory changes.

[39] *See Unlicensed Use of the 6 GHz Band et al*., ET Docket No. 18-295 and GN Docket No. 17-183, FCC 20-51, Report and Order and Notice of Proposed Rulemaking (rel. Apr. 24, 2020) at 9 (¶17) ("*6 GHz Report and Order*").

[40] WISPA Press Release, *ISP Industry Hails FCC Proposal to Unleash 6 GHz Band for Unlicensed Use* (Apr. 1, 2020) *available at* https://members.wispa.org/news_archive_headlines.php?org_id=WISP#26602619.

[41] *See* Concurring Statement of Commissioner Ajit Pai, *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act*, GN Docket No, 15-191, FCC 16-6, *2016 Broadband Progress Report*, 31 FCC Rcd 699, 781-82 (2016) ("What our country needs is a real broadband deployment agenda—a proactive, concrete, bipartisan, dedicated effort to deliver digital opportunity to every American who wants it. . . . In short, that means promoting competition. *That means getting rid of outdated rules and regulatory uncertainty*." (emphasis added)) ("*2016 Broadband Progress Report*"); *see also* Remarks of Commissioner Kevin J. Martin, *Framework for Broadband Deployment*, National Summit on Broadband Deployment (Oct. 26, 2001) ("*Regulatory uncertainty and delay function as entry barriers, limiting investment and impeding deployment of new services.* We should work to be faster and more reliable in our decisionmaking. Prolonged proceedings, with shifting rules . . . ultimately serve no one's interest, regardless of the substantive outcome.") *available at* https://transition.fcc.gov/Speeches/Martin/2001/spkjm101.html.

In 2017, at the request of the commercial mobile wireless industry, the Commission proposed to radically change its CBRS rules adopted just two years earlier.[42] The 2017 *CBRS NPRM* proposed to lengthen Priority Access License ("PAL") license terms to ten years, allow PALs to be renewed indefinitely, and sought comment on whether to enlarge the geographic areas that PALs would cover.[43] This sudden shift in direction, particularly the increase in the geographic size of the PALs, created not just tremendous uncertainty, but in many cases slowed further investment in money or other resources by WISPs that planned to use the 3.5 GHz band to grow their networks.[44] In reliance on the 2015 rules, WISPs had purchased equipment, constructed towers, and deployed service to tens of thousands of customers, using advanced LTE-based equipment that entered the marketplace.[45] For small businesses, whose major obstacle is access to capital, stranded and lost investments are a considerable barrier to entry and to growth, which in turn affects a small provider's ability to compete. WISPA appreciates the Commission's decision not to increase the geographic area licenses for PALs to much larger Partial Economic Areas, as requested by the commercial mobile wireless industry, and to instead adopt county-based license sizes.[46] WISPA expects its members to be active in the upcoming PAL auction. WISPA also commends the Commission for preserving General Authorized Access spectrum for "licensed-by- rule" use.[47]

[42] *See generally, Promoting Investment in the 3550-3700 MHz Band; Petitions for Rulemaking Regarding the Citizens Broadband Radio Service*, GN Docket No. 17-258, FCC 17-134, Notice of Proposed Rulemaking and Order Terminating Petitions, 32 FCC Rcd 8071 (2017) ("*CBRS NPRM*").
[43] *Id*. at 8076 (¶10).
[44] Comments of WISPA, GN Docket No. 17-258 (filed Dec. 28, 2017) ("WISPA CBRS Comments") at 14-22.
[45] *Id*.
[46] *Promoting Investment in the 3550-3700 MHz Band, Petitions or Rulemaking Regarding the Citizens Broadband Radio Service,* Report and Order, GN Docket No. 17-258, FCC 18-149, 33 FCC Rcd 10598, 10617 (¶35) (2018).
[47] *Id.* at 10599 (¶3) and 10618 (¶37).

WISPA also applauds the Commission's rejection of the commercial mobile wireless industry's most recent attempt to change the Commission's proposal for unlicensed use of the 6 GHz band in order to allocate significant portions of the 6 GHz band for exclusive use licenses and relocate incumbents, including WISPs, to another band.[48]

Going forward, WISPA requests that the Commission carefully consider any future changes in spectrum rules or policy that will materially alter the competitive landscape and strand the investment of small broadband providers. Spectrum is the engine for affordable, efficient and expeditions rural broadband deployment, and is working today to meet the increased demands of consumers. That need will not go away, and a sustained policy of making spectrum available under a variety of allocation schemes remains a critical element of Commission policy objectives.

B. Longstanding Regulations And Policies Based On Outdated Technology And Consumer Use Of Communications Services Are Major Impediments To Competition And Discriminate Against Fixed Wireless Providers

The Commission recently sought comment whether it should revisit and re-evaluate its rules governing competitive access to MTEs and the purported consumer benefits of various types of exclusivity agreements enjoyed by incumbent providers.[49] WISPA and many other commenters support Commission action to minimize the effects of several long-standing barriers to entry and growth in MTEs for competitive providers.[50] Regulatory action is necessary to fulfill the Commission's objectives to: (1) promote broadband access for the millions of Americans who live and work in MTEs but lack access to affordable broadband services;,(2) encourage facilities-based broadband deployment and competition in MTEs, and (3) as a result,

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[48] *See generally, 6 GHz Report and Order*.
[49] *Improving Competitive Broadband Access to Multiple Tenant Environments*, Notice of Proposed Rulemaking, GN Docket No. 17-142, FCC 19-65, 34 FCC Rcd 5702 (rel. July 12, 2019) ("*MTE NPRM*").
[50] *See generally*, WISPA MTE Comments, *supra* note 24; *and* WISPA MTE Reply Comments, *supra* note 25.

promote competition in the video distribution market and for other communications services. Moreover, assessing and eliminating regulatory and marketplace practices that serve as barriers to entry and growth, especially for small providers, serve the public interest and are authorized by the RAY BAUM'S Act.[51] Eliminating anticompetitive practices such as unreasonable exclusivity agreements, exclusive marketing arrangements, and revenue sharing agreements will encourage innovation in advanced fixed wireless technology using millimeter wave spectrum and foster increased competition in MTEs among different types of broadband providers, creating a true communications marketplace.

Cable operators in particular have enjoyed incumbency, if not monopoly, status in MTEs for decades and continue to receive preferential treatment from the real estate industry as well as from the majority of State mandatory access laws.[52] Decades ago, the Commission acknowledged that existing mandatory access laws initially designed to benefit new entrant cable/MVPD and telecommunications providers now serve as market entry barriers for newer technology providers, like WISPA's members, that do not meet the Title II or Title VI statutory classifications on which those laws are predicated.[53] State mandatory access laws compound the anti-competitive impact of unreasonable revenue sharing, wiring, marketing and rooftop access exclusivity agreements enjoyed by incumbents.[54]

Consistent with the RAY BAUM's Act, the Commission should recognize State mandatory access laws as a major barrier to entry, growth and competition.[55] WISPA

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[51] *See* 47 U.S.C. § 163(d)(3).
[52] WISPA MTE Reply Comments at iv.
[53] *See Exclusive Service Contracts for Provision of Video Services in Multiple Dwelling Units and Other Real Estate Developments*, Report and Order and Further Notice of Proposed Rulemaking, MB Docket No. 07-51, 22 FCC Rcd 20235, 20237 (¶3) (2007), *aff'd, National Cable & Telecommun. Ass'n v. FCC*, 567 F.3d 659 (D.C. Cir. 2009) (reporting that "the entry of incumbent LECs into the MVPD business has led incumbent cable operators to increase their use of exclusivity clauses in order to bar or deter the new entrants").
[54] *See* WISPA MTE Comments at 3.
[55] 47 U.S.C. § 163(b)(3).

emphasizes that "at a minimum," the Commission should encourage States and municipalities to make all current and future mandatory access laws technology-neutral.[56] Favoritism for traditional technologies or incumbent providers distorts the communications marketplace and restrict consumer choice.

When the Commission evaluates barriers to entry in MTEs for competitive providers, it must acknowledge new technology readily available to deliver broadband services. It must also act to mitigate the long-standing discriminatory practices against new entrants and new technology that have been allowed, if not reinforced, by outdated Commission regulations, as well as statutory classifications and various State mandatory access laws that harken back to a binary market that no longer exists.[57]

Similar outdated rules and technology that restrict the types of over-the-air reception devices ("OTARD") currently permitted to be installed on the premises of residential or commercial customers serve as longstanding market entry barriers for new entrants using fixed wireless technology.[58] The Commission initiated its OTARD rulemaking proceeding more than a year ago to modernize and update the OTARD regulatory framework and facilitate the deployment of modern fixed wireless infrastructure to meet consumer demand and to provide competition.[59] WISPA supports updating the OTARD rule to apply to "all fixed wireless transmitters and receivers, regardless of whether the equipment is used for reception, transmission, or both, so long as the equipment meets the existing size restrictions for customer-

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[56] WISPA MTE Comments at 29.

[57] *See generally*, WISPA MTE Comments and WISPA MTE Reply Comments.

[58] *See generally*, Comments of WISPA, WT Docket No. 19-71 (filed June 3, 2019) ("WISPA OTARD Comments").

[59] *Updating the Commission's Rule for Over-the-Air Reception Devices*, Notice of Proposed Rulemaking, WT Docket No. 19-71, FCC 34 FCC Rcd 2695 (rel. Apr. 12, 2019) ("*OTARD NPRM*").

end equipment."[60] The extension of the OTARD rule protections to include fixed wireless hub and relay antennas at a consumer's premises will enable WISPs to provide better and more affordable fixed wireless broadband service to more rural consumers by lowering barriers to siting fixed wireless base stations closer to consumers' homes and businesses. Extending OTARD protection is critical for modern fixed wireless networks, especially in rural areas where there is less infrastructure available for deployment.[61]

C. Government Subsidized Overbuilding Is A Waste Of Valuable Public Resources And Undermines Local, State And Federal Efforts To Deploy Broadband To Unserved And Underserved Communities

"Broadband has become essential to the full and meaningful exercise of the fundamental rights and privileges of citizenship in the United States, and we need to ensure that all Americans have access to this critical resource."[62] This statement from the Commission's Federal Advisory Committee on Diversity and Digital Empowerment ("ACDDE") has never been truer than today in the midst of a global health crisis. The current COVID-19 pandemic clearly illustrates that the continuing disparity between those who have access to high-speed broadband and those that do not is a matter of national concern.

> The coming weeks will lay bare the already-cruel reality of the digital divide: tens of millions of Americans cannot access or cannot afford the home broadband connections they need to telework, access medical information and help young people learn when school is closed. When public health requires social distancing

[60] *Id.* at 2696 (¶5) (quoting Letter from Claude Aiken, President and CEO, WISPA, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 17-79 at 1 (filed Aug. 27, 2018)).

[61] *See* Letter from Claude Aiken, President and CEO, WISPA, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 17-79 at 5-6 (filed Mar. 14, 2019) (discussing that "extension of OTARD protections to 'hub sites' is critically important for rural areas, where heavy foliage and undulating terrain can make deployment more difficult.").

[62] FCC Advisory Committee on Diversity and Digital Empowerment, Digital Empowerment and Inclusion Working Group, *Universal Digital Access Observations and Recommendations to Help Bridge the Digital Divide for All Americans*, ratified by the full ACDDE (June 24, 2019) *available at* https://www.fcc.gov/news-events/events/2019/06/advisory-committee-diversity-and-digital-empowerment-meeting-june-2019 ("*FCC ACDDE Overbuilding Prevention Principles*").

> and even quarantine, closing the digital divide becomes central to our safety and economic security.[63]

One of the major obstacles to closing the digital divide is government subsidized overbuilding, which is the practice of using public money to support competition with existing broadband providers. As the ACDDE stated, "overbuilding any area with scarce public funds that already receives sufficient broadband service diminishes the reach and effectiveness of such funds because there is zero investment in communities that have *no* access to broadband – the truly unserved. In today's race to promote 5G technology, too many communities have 'no G' and thus, should be a top priority for any such funding."[64]

Commissioner O'Rielly has recognized the dangers of government funding for overbuilding to areas where there is sufficient access to broadband, commenting that "[w]hen one provider received special funding, it distorted the ability of non-recipients to operate, pay off debt, raise capital, and satisfy consumer interest."[65] Access to capital is always a challenge for small businesses and many WISPs have built their networks without government subsidies by maximizing private capital (including funds from family and friends, credit cards and debt). The danger of overbuilding is even greater when unsubsidized small providers such as WISPs have invested their own capital to provide service where larger service providers have not.[66] With billions of dollars in federal funding to expand rural broadband deployment,[67] unsubsidized

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[63] Commissioner Geoffrey Starks, *To Fight Coronavirus, Millions More Americans Need Internet Access*, THE NY TIMES (Mar. 19, 2020) *available at* https://www.nytimes.com/2020/03/19/opinion/internet-broadband-coronavirus.html.

[64] *FCC ACDDE Overbuilding Prevention Principles* at 3.

[65] FCC Commissioner Michael O'Rielly, *Federal Broadband Infrastructure Spending: Potential Pitfalls*, FCC BLOG (Feb. 1, 2017), https://www.fcc.gov/news-events/blog/2017/02/01/federal-broadband-infrastructure-spending-potential-pitfalls.

[66] WISPA's members are more likely to be the first and only provider in many rural high-cost areas.

[67] *See FCC ACDDE Overbuilding Prevention Principles* at 2-3; *see also RDOF Order*, *supra* note 6, at 688 (¶2) (launching the $20.4 billion Rural Digital Opportunity Fund).

WISPs "must now more nimbly maneuver in an atmosphere which, if not properly managed, can result in overbuilding of their service territories by government-subsidized providers."[68]

Therefore, preventing government subsidized overbuilding is critically important to promote investment and innovation, and for the prudent use of taxpayer money. Congressional leaders also have raised concern regarding the risks of duplicate efforts to build in certain communities and wasting taxpayer money, and thus have strongly encouraged increased communication and cooperation between the RUS and the Commission.[69] The ACDDE supports increased coordination between *all* government entities, including local and State entities.[70] The ACDDE has also emphasized that all government stakeholders coordinate efforts and maintain close communications to ensure that funding is first provided in areas that really need it.[71] WISPA supports this approach.[72] With increased infrastructure and economic stimulus

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[68] WISPA Press Release, *Claude Aiken Praises WISP Industry's Strong Growth and Community Service in WISPAPALOOZA Address* (Oct. 16, 2019) available at https://members.wispa.org/news_archive_headlines.php?org_id=WISP#25401393. Not all WISPs qualify for Federal subsidies because they only offer broadband and do not offer voice telephony services. A combination of broadband and voice services is a prerequisite for subsidies under the FCC's high-cost support programs.

[69] *See generally* Letter from Chairman John Thune, U.S. Senate Committee on Commerce, Science and Transportation, and Chairman Roger Wicker, Subcommittee on Communications, Technology, Innovation and the Internet, to Secretary Sonny Perdue, U.S. Dept. of Agriculture (Aug. 22, 2018) available at https://www.ntca.org/sites/default/files/documents/2018-08/Sen%20Thune%20USDA%20letter.pdf?utm_source=facebook.

[70] *FCC ACDDE Overbuilding Prevention Principles* at 7.

[71] The FCC ACDDE recommended that local, state, and federal public funding (subsidies, loans, grants or loan/grant combinations) be allocated "only to designated geographic areas that lack access to terrestrial broadband service offering a minimum 10 Mbps download/1 Mpbs upload speeds ('10/1'). This assessment should include, but is not limited to, any current or pending award or distribution of public funds at the local, state or federal level, regardless of the stage of construction. If government funding has been designated (e.g., through the CAF Phase II auction or a RUS broadband loan program), awarded or distributed, the area is deemed to have sufficient service and would not receive additional funding support." *FCC ACDDE Overbuilding Prevention Principles* at 7; *see also* Sec. 779, Consolidated Appropriations Act, 2018, Pub. L. No. 115-141 (2018) (mandating that RUS provide funding under the e-Connectivity Pilot Program only to those providers that will deploy high-speed broadband "in a rural area without sufficient access to broadband, defined for this pilot program as 10 Mbps downstream, and 1 Mbps upstream . . . .").

[72] *See* Comments of the Wireless Internet Service Providers Association, Docket No. RUS-18-TELECOM-0004 (filed Sept. 10, 2018) ("WISPA RUS e-Connectivity Comments") at 7-8.

legislation expected during the COVID-19 pandemic,[73] it is in the public interest to ensure that the Commission first target locations that lack broadband at minimum speeds of 10/1 Mbps. Said another way, during a hunger crisis government should ensure that everyone is fed first before those lucky enough to have sufficient food to survive get second helpings.

D. An Important Tool To Prevent Overbuilding Is Accurate And Timely Reporting Of Broadband Deployment Data

Small providers are particularly harmed when government does not take reasonable precautions to prevent overbuilding by using outdated deployment data to determine areas eligible for funding.[74] Additionally, small providers are harmed when the reporting process for deployment is burdensome and unrealistic and takes extensive human and financial resources to comply.[75] There must be a balance between accuracy and timeliness, on one hand, and reducing the burden on providers, especially small providers, on the other hand.[76]

Acknowledging the broadband mapping problem, Congress enacted the Broadband Deployment Accuracy and Technological Availability Act of 2020 ("Broadband DATA Act"), which was signed into law on March 23, 2020.[77] "With better maps, the Broadband DATA Act will focus limited government support to areas that truly lack broadband, guaranteeing that more Americans can access the Internet through broadband.[78] But, as Chairman Pai has stated, this legislation lacks appropriation, curtailing the Commission's ability to move forward.[79]

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[73] *See* Clyde Wayne Crews, Jr., Phase 4 Coronavirus Infrastructure Spending to Start at $2 Trillion, Forbes (Mar. 31, 200) *available at* https://www.forbes.com/sites/waynecrews/2020/03/31/phase-4-coronavirus-infrastructure-spending-to-start-at-2-trillion/#53c3772d7099.
[74] *FCC ACDDE Overbuilding Prevention Principles* at 6.
[75] *See* Comments of WISPA, WC Docket Nos. 19-195 and 11-10 (filed Sept. 23, 2020) ("WISPA DODC Comments").
[76] *See* Reply Comments of WISPA, WC Docket Nos. 19-195 and 11-10 (filed Oct. 7, 2019) ("WISPA DODC Reply Comments") at 6.
[77] Pub. L. No. 113-101, codified at 47 U.S.C. § 641.
[78] WISPA Press Release, *WISPA Applauds President's Signing of Bipartisan DATA Act*, Mar. 24, 2020.
[79] FCC Statement, Chairman Pai Statement on the Broadband Data Act, Mar. 24, 2020, available at https://docs.fcc.gov/public/attachments/DOC-363267A1.pdf.

Access to more granular and accurate data of where broadband is available and where it is not will be essential to Phase II of the RDOF program, which will offer at least $4.4 billion in support, much of it to partially served census blocks. To address the need for more accurate, granular and timely deployment data, WISPA and several other trade associations and providers partnered to develop a methodology that recognizes the inherent differences in broadband technology but is not overly burdensome for any one technology. This industry coalition engaged CostQuest Associates, Inc. to develop the "Broadband Serviceable Location Fabric" via a two-State pilot program in 2019.[80] The pilot's methodology used "state of the art technology and a combination of public and commercial datasets . . . to identify and precisely locate virtually every structure in a geographic area that is capable of receiving broadband."[81]

WISPA hopes the Commission will promote the development of the broadband serviceable location fabric in the Digital Opportunity Data Collection proceeding.[82] With new techniques and data sets to map locations and broadband availability, the Commission can better ensure that its finite support will be allocated where it is needed, and not to areas where adequate broadband is available.

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[80] Jim Stegeman, *Broadband Mapping Initiative: Proof of Concept*, Summary of Findings, CostQuest Associates, Inc. (August 2019) at 2, *available at* https://ecfsapi.fcc.gov/file/1082010869365/UST%20BSLF%20PoC%20Findings%20-%20August%202019.pdf.

[81] *Id.* at 4. Reporting entities would be required "to submit polygons into a portal to define served areas that are not restricted by census-block designations or other geopolitical boundaries. Polygons (geospatial data that define coverage areas) will be less likely to overstate or understate broadband availability in rural areas than geopolitical boundaries, providing more accurate and precise data on where the Commission should be supporting broadband through its high-cost programs. Such data would also be a less burdensome reporting metric for WISPA's members than reporting via census blocks, road segments, or street addresses, or conducting geocoding. The anticipated availability of a broadband serviceable location 'fabric' will provide considerable assistance in determining those areas where broadband is available and where future subsidy dollars should be allocated. WISPA Sec. 706 Comments at 6-7 (citations omitted).

[82] *See* WISPA DODC Reply Comments at 6.

E. The Commission Should Ensure Broadband-Only Providers Have Access At Just And Reasonable Rates To Pole Attachments, Conduits And Rights-Of-Way

The Commission recently sought comment whether its 2018 Restoring Internet Freedom Order ("*RIF Order*") that re-designated broadband Internet access service providers as "information providers" under Title I also imposed regulatory barriers on broadband providers that are not telecommunications or cable providers regarding infrastructure access, such as pole attachments, conduits and rights-of-way in states that have not certified state authority over such infrastructure.[83] For WISPA's members, the *RIF Order* eliminated the vast burdens of Title II utility-style regulation and substantially reduced compliance costs for broadband-only providers, allowing these savings to be invested into the expansion of services and network enhancements such as the deployment of fiber to complement fixed wireless technology.[84] However, the *RIF Order* also eliminated a broadband-only provider's non-discriminatory access rights to poles, conduits and rights-of-way historically enjoyed by incumbent telecommunications and cable providers under Section 224 of the Communications Act of 1934, as amended.[85]

WISPs' efforts to expand and enhance services in rural and other high-cost areas using fiber technology are hampered, if not undermined, by difficulty accessing crucial infrastructure at affordable costs.[86] "In small communities that lack sufficient vertical infrastructure, such access may be the only viable way to extend service. If access is denied altogether or if the rates to access the required physical structures and spaces are not just and reasonable, however, the

[83] *See* Public Notice, *Wireline Competition Bureau Seeks to Refresh Record in Restoring Internet Freedom and Lifeline Proceedings in Light of the D.C. Circuit's Mozilla Decision*, WC Docket Nos. 17-108, 17-287 and 11-42, DA 20-168 (rel. Feb. 19, 2020) at 2.
[84] Comments of WISPA, WC Docket Nos. 17-108, 17-287 and 11-42 (filed Apr. 20, 2020) at 6-7 ("WISPA RIF Refresh Comments").
[85] *See id.* at 8.
[86] *See Mozilla Corp. v. FCC*, 940 F.3d 1, 59 (D.C. Cir. 2019) ("[P]ole attachments are 'crucial to the efficient deployment of communications networks including, and perhaps especially, new entrants.'" (citation omitted)).

upfront investment in combination with the high cost to deploy fiber may be prohibitive, especially if the sparse population cannot support a return on that investment."[87]

Timely Commission action to require just and reasonable access to infrastructure for non-telecommunications and non-cable providers would eliminate a major market entry barrier and impediment for growth for small broadband providers and new entrants by leveling an unequal playing field and would reduce costs to consumers.[88] To this end, WISPA has requested that the Commission exercise its "ancillary authority under Title I, to maintain equitable access to poles, conduits and rights-of-way for WISPs and other broadband-only providers that do not fall within the two defined categories of providers in Section 224."[89]

F. Other Regulatory Barriers For Small Providers Hamper A Competitive Marketplace and Restrict Access to Capital

With respect to the CAF, WISPA notes that the existing letter of credit rules create financial burdens that are disproportionate to the Commission's financial risk and divert support to banks instead of broadband deployment.[90] For RDOF, based in part on WISPA's advocacy, the Commission rectified this by substantially reducing the value of letters of credit to better balance the Commission's objectives, thereby freeing up more capital for buildout and making it easier for recipients to obtain letters of credit.[91] The Commission is considering a request for waiver and a petition for rulemaking that would enable CAF Phase II recipients to obtain the

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[87] WISPA RIF Refresh Comments at 8.
[88] *Id.* at 10 ("[P]reservation of a system that gives only well-heeled incumbents a statutory right of access to utility poles would, in a Title II world, maintain an unfair business environment and would serve as yet another market entry barrier for small broadband providers and new entrants." (citation omitted)).
[89] *Id*. at 9.
[90] *See, e.g.,* Comments of WISPA, WC Docket Nos. 10-90 and 14-58, RM-11853 (filed Apr. 10, 2020) supporting requests for waiver filed by the CAF Phase II Coalition and Skybeam, LLC).
[91] *See RDOF Order, supra* note 6, at 731-32 (¶105).

same benefit that RDOF recipients will obtain.[92] A similar request for waiver recently was filed by providers eligible to participate in the upcoming Uniendo a Puerto Rico and Connect USVI Fund.[93] WISPA strongly supports these requests, which will assist participants in these programs, particularly smaller providers, to reduce regulatory and financial obligations and make it easier for them to compete for funding.

Conclusion

The fixed wireless broadband industry continues to be the fastest growing broadband access sector in the United States and globally, providing low cost, low latency, and reliable high-speed service to residential and business consumers, educational institutions, public safety and medical facilities, farms and entire communities in rural and other underserved or unserved areas. Fixed wireless technology is being deployed to homes, businesses and MTEs in an expedited cost-effective manner for a fraction of the cost of cable and fiber. WISPs have also been at the forefront of providing Gigabit speeds in rural areas and are recognized as providing the best technology to help bridge the digital divide. Even with these accomplishments, WISPs continue to face obstacles from competitors and regulatory barriers that hamper the ability for WISPs to compete and grow their networks. With continued recognition of the inherent characteristics and benefits of fixed wireless technology and elimination of regulatory barriers to

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[92] *Request for Waiver of Section 54.315(c) to the Commission's Rules Pending Action on a Petition for Rulemaking Seeking Amendment of the Commission's CAF II Letter of Credit Requirements Consistent with Rule Changes Adopted for the Rural Digital Opportunity Fund*, Request for Waiver (Mar. 10, 2020) *available at* https://ecfsapi.fcc.gov/file/10310008159997/CAF%20II%20Coalition%20Request%20for%20Waiver%20(3-10-2020).pdf.

[93] PR-USVI Fund Coalition Emergency Request For Waiver, WT Docket No. 18-143 (filed Apr. 7, 2020) *available at* https://ecfsapi.fcc.gov/file/1040765496279/PR%20USVI%20LOC%20Waiver%20Request.pdf.

entry and growth for small providers, the Commission will foster a healthy communications marketplace that will benefit all Americans.

Respectfully submitted,

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April 27, 2020

APPENDIX A

Finley Engineering Report

FINLEY ENGINEERING
INTEGRITY INTO EVERYTHING

UNDERSTANDING THE EXPANDING FIXED WIRELESS BROADBAND OPPORTUNITY

Introduction

Broadband service delivered via fixed wireless has a long and rich history here in the U.S. and abroad. Its popularity and interest continue to rise. Fixed wireless access (FWA) draws interest and attention because of relatively favorable network economics, when compared to more expensive wireline options.

The historical context and growth of FWA has centered on these favorable network economics. Smaller and more rural markets often lack the population density to make wireline broadband networks feasible. The business case sometimes doesn't compute, making fixed wireless a preferred option for many rural markets. But the improving capabilities of FWA are now expanding the potential use cases.

Broadband providers of all sizes and stripes are now adding FWA to their portfolio to serve many different market applications -- urban, suburban, and rural included. Improving FWA technology makes the application more attractive, even rivaling wireline broadband capabilities in some instances. This whitepaper will examine the case for FWA as a legitimate broadband architecture to meet the needs of the evolving broadband access industry.

State of Fixed Wireless in the U.S.

According to the 2017 Broadband Wireless Access (BWA) Industry Report from research firm Carmel Group and several industry associations, there are approximately 2,000 wireless internet service providers (WISPs) in the U.S., serving over 4 million customers[1]. Online ISP rankings and resource website BroadbandNow has data on 1,549 operating WISPs in the U.S. today. Just over half of them, or about 800, are members of WISPA, the major trade association representing the fixed wireless community. The BWA Industry report states that the average WISP in the U.S. serves 1,200 customers, with the largest WISP, Rise Broadband, serving north of 200K subscribers.

The average fixed wireless subscriber gets 3 Mbps download speed when active, according to FWA technology supplier Preseem. Data from the Preseem Fixed Wireless Network Report – 1Q19 shows that the average fixed wireless subscriber uses 6.7 gigabytes (GB) of data per day for a total of 201 GB per month[2].

The BWA Industry Report data pegged annual WISP subscriber revenue at $2.3 billion and projected it to more than double to $5.2 billion by the end of 2021. According to WISPA, most WISPs serve rural territory and many of the organization's members have subscriber counts in the low hundreds.

As this data suggests, most of the FWA momentum has taken place in rural markets and that looks to continue, although not exclusively. FWA interest is growing, both from tier 1 providers like Verizon, AT&T, and T-Mobile, as well as from upstarts such as Starry Internet and others. These newer entrants into the FWA arena seem more focused on urban and suburban applications, providing very high-bandwidth services using emerging technologies and spectrum bands such as 5G and CBRS as direct competitive alternatives to wireline broadband options.

Rural Markets

In rural markets, FWA's sweet spot, additional growth is coming from newfound attention as well. As policymakers at both the state and federal levels continue to push policies that address fixing the digital divide, FWA is increasingly seen as a big part of the solution. You don't have to look any further than the recently concluded Connect America Fund II Auction (CAF-II) to see evidence of this.

A significant amount of CAF-II funding, $750 million, was awarded to companies who plan to utilize FWA as their primary broadband access technology. That includes Finley Engineering client Watch Communications, a subsidiary of Benton Ridge Telephone Company, a top 10 winner in the CAF-II auction who will deploy fixed wireless to 24K additional locations. At least 16 fixed wireless service providers won funding through the CAF-II auction[3], according to WISPA. In addition, some companies not known primarily as WISPs plan to use FWA for CAF-II deployments.

This rural momentum has caught the eyes of blue-chip technology companies like Microsoft as well, who are also active in the rural FWA movement. Through its Airband initiative, Microsoft has partnered with over 8 service providers thus far to expand broadband in rural markets across 16 states, relying in large part on TV white spaces technology[4].

Larger traditional wireline carriers including Windstream and Frontier are turning to FWA to expand their rural broadband footprints as well. Windstream is using 3.5 GHz spectrum to deliver 100 Mbps capable broadband to several markets, with plans to expand to additional rural markets[5]. The company also was a big bidder – and winner – in the recent auction of millimeter wave spectrum in the 24 GHz and 28 GHz bands, which the company is expected to use to support FWA. Frontier also won millimeter spectrum in the 28 GHz band and is likely to use it for FWA.

Fiber broadband and mobile provider C Spire, based in the southeast, also is moving aggressively with FWA. Even traditional cable operator Midcontinent has turned to FWA to increase its rural broadband footprint[6].

Emerging Fixed Wireless Technology

Fixed wireless applications in rural markets have historically been 802.11-based, with many deployments using the unlicensed 2.4 GHz and 5.8 GHz spectrum ranges. FWA technology is improving dramatically, though, enabling much better performance and capability and coming closer to matching wireline performance. Some of the new technologies leverage development work already completed involving LTE and 5G. Other spectrum bands also are emerging for FWA use, including TV white spaces and the citizens band radio service (CBRS) band, as well as bands that are expected to be used for 5G.

Fixed LTE

LTE use cases traditionally have revolved around mobile broadband applications, but the technology's use for FWA is on the rise. According to a Mobile Exports report, demand for dedicated LTE fixed wireless access point equipment will grow faster than traditional fixed wireless equipment and is forecasted to grow from $430 million in 2017 to $1.2 billion in 2023[7].

Larger carriers such as T-Mobile and U.S. Cellular are helping fuel this growth by utilizing LTE for fixed wireless applications. T-Mobile Home Internet using fixed wireless will offer 50 Mbps broadband and sell for $50 per month. The carrier says it has a goal of reaching 50K subscribers with the service in 2019[8]. U.S. Cellular announced last year that trials using LTE for fixed wireless in Kansas and Nebraska were very encouraging and the carrier intends to expand its fixed LTE footprint into additional rural markets[9].

Smaller carriers are also interested in utilizing LTE for FWA. Oklahoma-based Pioneer Telephone Cooperative announced last year its intention to add LTE fixed wireless capability to 400 towers across its footprint. The FWA deployment will also be used to expand broadband access to underserved and unserved markets through the FCC's A-CAM program[10].

CBRS Opportunities

Many carriers, large and small, are welcoming the CBRS opportunity for fixed wireless. The band includes spectrum between 3.5-3.7 GHz, encompassing the existing 3.5 GHz band and additional spectrum, and offers great promise for fixed wireless operators. There will be both unlicensed and licensed spectrum options for CBRS. The FCC recently established rules for the auction of the licensed spectrum associated with CBRS. Additionally, the CBRS band can support LTE and could soon support standards-based 5G as well.

CBRS is attractive for FWA thanks to its favorable propagation characteristics and high bandwidth capabilities. It generally doesn't require line of sight, although dense foliage will negatively impact it's coverage. Several carriers are already testing CBRS with 100 Mbps speeds or better. There are numerous use cases for CBRS, including, FWA, mobile, and even private networks. The CBRS Alliance, a special interest group made up of vendors and carriers has created a brand for CBRS service called OnGo, following the legacy of Wi-Fi, which was established by the Wi-Fi Alliance.

CBRS has seen a lot of interest and may even help increase service provider network valuations. Large swaths of spectrum may be available to rural providers, allowing for high-bandwidth, high-performance networks. The involvement of larger carriers, particularly though the licensed portion of the CBRS opportunity, will help drive down costs for all providers. Rural industry banker CoBank recently issued a bullish report on CBRS, suggesting the spectrum will help drive up the value of operators and may provide an attractive financial exit strategy[11].

TV White Spaces Broadband

TV white spaces technology uses vacant TV broadcast spectrum, which is considered low-frequency, or low-band, spectrum. Broadband providers don't need a license to use the spectrum, but they are required to use equipment supporting spectrum sharing technology. That technology uses a database to identify channels that are not licensed in an area to assign the equipment to vacant channels.

TV broadcast spectrum is low-frequency spectrum with excellent propagation characteristics, allowing for wide range. TV white space transmissions are good at penetrating walls and foliage and can operate in non-line of sight applications. There are already equipment options available.

Microsoft has seized on the TV white space broadband opportunity here in the U.S. and abroad. The technology giant has become active in trying to address the digital divide through its Airband program and partners with WISPs to leverage TV white space. As of the Spring of 2019, the partnership includes 8 WISPs, serving territory in 16 states. Microsoft reports their Airband partners are achieving the 25/3 Mbps FCC broadband definition[12] using FWA.

5G FWA

Early use cases for 5G include fixed wireless. The next generation of wireless service can provide very high bandwidth FWA, even providing gigabit-capable broadband. The technology is being billed as a potential alternative to FTTH and DOCSIS based broadband services.

Initial 5G FWA deployments have utilized millimeter wave spectrum, which is generally defined to include bands in the range of 24 GHz and higher. These bands provide very high bandwidth capability, but over very short distances. Range from a tower or small cell may be only in the range of 500 to 1000 feet, although some carriers claim somewhat longer distances. Nevertheless, 5G FWA in the millimeter wave bands is likely to be more of an urban than rural application.

Verizon has been the most aggressive thus far with 5G FWA, having already launched it in several cities. Verizon says it eventually intends to pass 30 million homes with 5G FWA but will focus on urban and suburban markets[13]. T-Mobile and Sprint have suggested a 5G FWA solution that could eventually reach rural markets, utilizing Sprint's 2.5 GHz spectrum and T-Mobile's 600 MHz spectrum (assuming the two companies are allowed to merge).

There are several wireless carriers who brand their FWA service as 5G without meeting true 3GPP 5G standards. These services tend to be higher bandwidth FWA and can use a variety of technologies including LTE.

Conclusion

Fixed wireless service has a long history here in the U.S. and is undergoing a bit of a renaissance. Emerging technologies and spectrum bands are adding many more capabilities to this tried and proven broadband wireless application. These emerging technologies and spectrum bands include LTE, CBRS, TV white spaces, and 5G.

Service providers, wireless and wireline alike, should evaluate all these options for potential use cases. Expanding into adjacent markets, bringing service to the unserved and underserved, and complementing existing broadband service to fill-in coverage gaps are but a few potential applications for FWA.

The future looks bright for FWA, as policymakers increasingly see the technology as part of the answer to address the digital divide. This creates momentum that should benefit the overall industry, helping to drive costs lower due to greater economies of scale. Finley Engineering has vast experience in helping service providers evaluate FWA opportunities and engineer networks that best utilize the technology. We look forward to working with a growing number of service providers who see FWA as a part of their broadband future.

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For more information and wireless expertise, contact Finley Engineering. We specialize in this area and are glad to assist you. 800-225-9716

APPENDIX B

Maravedis 5G Analysis

MARAVEDIS
Wireless Infrastructure Analysts

5G Fixed Wireless Gigabit Services Today

An Industry Overview

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Executive Summary

This white paper discusses the advantages of using millimeter wave (mmWave) technologies, such as those being developed for the fifth generation (5G) of mobile telecommunications, to deploy fiber-like, Fixed Wireless Access (FWA). 5G FWA can provide gigabit broadband service using both licensed and unlicensed mmWave spectrum, making it an ideal option for both small and large internet service providers (ISPs). Furthermore, since the cost and speed of 5G FWA infrastructure deployment easily beats the cost and time required to extend fiber-optic cables straight to the premises (fiber-to-the-premises, FTTP, or fiber-to-the-home, FTTH), 5G FWA allows fiber networks to easily be deployed and scaled without compromising broadband speed or reliability.

The use of mmWave spectrum offers service providers an excellent opportunity to stay competitive considering ineffective, monopolistic broadband services in the U.S. In 2016, the U.S. Federal Communications Commission (FCC) released a report that concluded that "advanced telecommunications capability is not being deployed to all Americans in a reasonable and timely fashion." A large contributing factor to this problem is the domination of spectrum by large ISPs like Verizon and AT&T. While these companies have managed to purchase a significant portion of licensed mmWave spectrum, such as the 28 GHz band, the FCC has allocated 14 GHz of contiguous unlicensed spectrum in the 60 GHz V-Band. This gives small ISPs the chance to utilize mmWave technology without the large cost needed to purchase licensed spectrum.

Using unlicensed or lightly-licensed mmWave frequencies, such as the 60 GHz V-Band or 70/80 GHz E-Band, is therefore a cost-effective choice for deploying fiber-like 5G FWA. Commercial mmWave radios are capable of operating in a point-to-point (PtP) or point-to-multipoint (PtMP) topology to deliver gigabit broadband to businesses, Multiple Dwelling Units (MDUs), and single-family homes and are currently available for deploying 5G FWA. In addition to the cost, time, and scalability advantages of 5G FWA (as opposed to FTTH), a multitude of 5G trials and deployments have validated the technology for 5G FWA. Even though the final 5G standard isn't expected until 2020, many service providers around the world plan to roll out pre-standard 5G networks as early as 2017. As the technology has been demonstrated and offers several advantages, including gigabit throughput and inexpensive infrastructure, 5G FWA solutions present an appealing option for service providers looking to extend their coverage and compete with larger ISPs.

As demonstrated in the business cases presented in this white paper, mmWave is the most cost-effective solution in both single units and multi dwelling units – deployment scenarios. But carriers don't have to choose between mmWave and fiber, they need both since these technologies complement each other to provide the most cost-effective solution under the Hybrid Fiber-Wireless (HFW) model.

The HFW is a disruptive model for providing GTTH built on proven technology. This model adds high frequency wireless radios to a fiber network, drastically reducing deployment costs, time to install and offers the potential to provide multiple gigabits directly to the consumer. Simply put: by using HFW, providers can deploy gigabit first and for much cheaper than competitors. Using an HFW connectivity model in a residential market will result in a quantum leap in profitability.

1. Background

1.1 Broadband Access Challenges in the US

Broadband internet service in the U.S. has been plagued by uncompetitive practices. Large, nationwide internet service providers (ISPs) have built monopolies that prohibit innovation, drive down levels of service, and block competitors from entering the market. In their 2016 Broadband Progress Report[1], the Federal Communications Commission (FCC) found that only 38% of Americans have more than one choice of broadband provider, and only 10% of Americans have access to broadband speeds of up to 25 Mbps downlink/3 Mbps uplink. Many Americans lack access to broadband internet entirely, especially in rural areas: 39% of rural Americans, 4% of urban Americans, and 41% of Americans living on Tribal lands do not have access to broadband services. Considering these factors, the FCC concluded that "advanced telecommunications capability is not being deployed to all Americans in a reasonable and timely fashion."

Compounding this issue is the ever-increasing consumer demand for broadband access. Online media continues to grow in popularity, and as a result, many wireline and cable service providers are experiencing customer churn. In the first quarter of 2017, 612,000 Americans cancelled their pay-tv subscriptions (referred to as "cutting the cord"), and an additional 10.8 million pay-tv subscribers are predicted to cut the cord by 2021[2]. As pay-tv gives way to online subscription services, the need for fast and reliable broadband internet is vital as slow internet with and low capacity results in buffering that is unacceptable by customers when watching online TV programs.

1.2 A Growing Opportunity

Some organizations have attempted to provide a better broadband option to consumers through the deployment of fiber-optic networks. For example, Google Fiber, announced in 2010, offers fiber-to-the-home (FTTH) high-speed broadband internet with downlink speeds of up to 1 Gbps[3]. Verizon Fios is another FTTH fiber solution that offers high speed broadband, up to a “Fios Gigabit Connection” of 940 Mbps down/880 Mbps up[4]. Such networks serve to raise consumer expectations of broadband internet, pressuring ISPs to improve service. However, deploying fiber networks is a slow and expensive process, with an installation cost estimated to be approximately $1000 per home[5]. Accordingly, despite the high speeds available with fiber, time and cost expenses prohibit fiber as a practical broad band remedy.

Therefore, to overcome the problems of anti-competitive ISPs and increasing demand for high speed broadband services, a new solution is required. A promising option is to adopt millimeter wave (mmWave) technology, which covers the spectrum from 30 – 300 GHz, to deploy fixed broadband wireless solutions. In 2015, the FCC proposed licensing for spectrum bands in the mmWave range, including 27.5 – 28.35 GHz, 37 – 38.6 GHz, 38.6 – 40 GHz, 57 – 64 GHz, and 64 – 71 GHz to prepare for future Fifth Generation (5G) mobile services[6]. Though mmWave bands show potential for future broadband services, many of them suffer from the existing problem of ISP monopolies. With recent multi-billion-dollar acquisitions of smaller providers, large ISPs like AT&T and Verizon have already begun dominating ownership of mmWave bands. Together, these two companies own over 50% of available licensed mmWave spectrum in the U.S.7 [8].

However, service providers that can’t afford the cost of licensed mmWave bands have another option: the use of unlicensed mmWave bands, such as the 60 GHz V-Band. With 14 GHz of contiguous spectrum available, and commercial chipsets and products already developed for this band, providers can deploy gigabit-to-the-home (GTTH), fixed wireless access (FWA) for nothing more than a minimal cost of infrastructure[7].

Thus, the unlicensed 60 GHz V-Band offers service providers an excellent opportunity to offer competitive gigabit services.

1.3 Market Potential

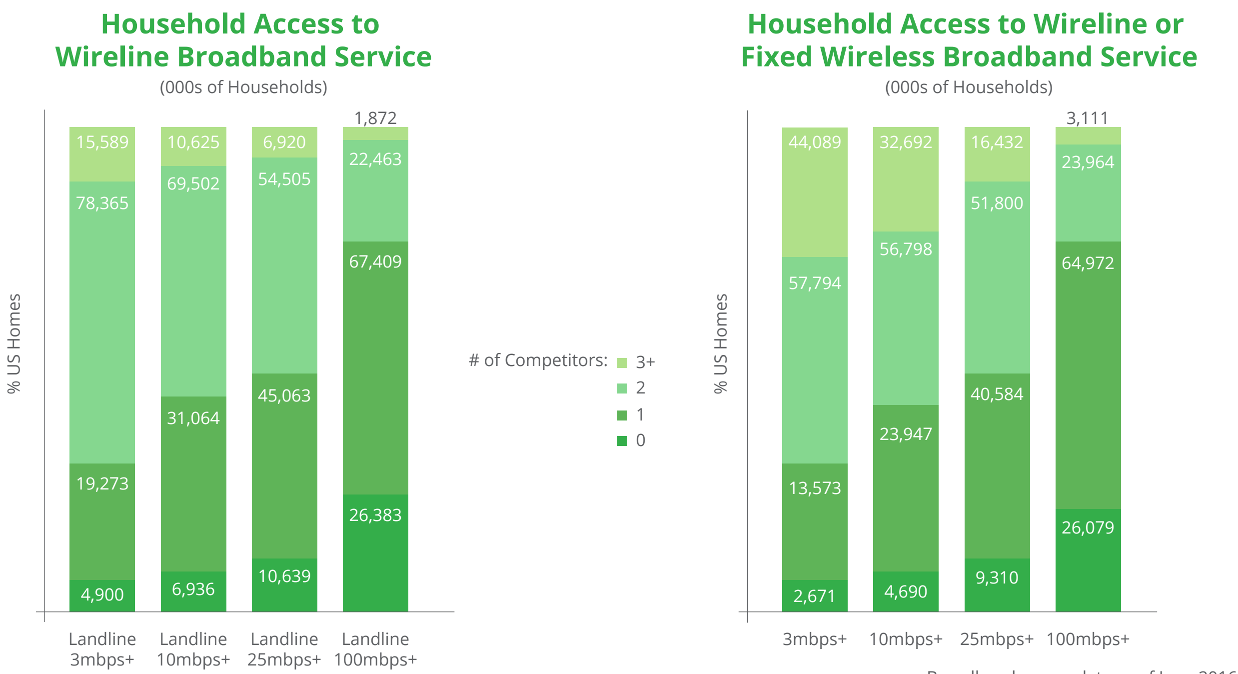
There are close to 126 million households in the US, out of which 106 million have some form of broadband. However, as we saw previously, only a very small fraction have access to 21th century broadband above 100 Mbps which is required to empower users with the emerging applications in the connected home including 4K and 8K televisions, virtual reality, IoT, and the proliferation of user devices. In other words, homes are rapidly becoming high density wireless environments which require way beyond 100 Mbps connectivity.

FCC reports have found that about three-quarters of the country's developed census blocks lack any high-speed broadband choice. The household analysis found a slightly better, but still troubling, situation, with nearly half of the 118 million US households lacking any wired internet choice at the FCC's broadband standard of 25 Mbps. (One caveat: this new analysis examined only download speeds, whereas FCC reports define broadband as services offering both 25 Mbps download speeds and at least 3 Mbps uploads). With the growing popularity of 4k streaming which requires up to 25Mbps for single TV, the 25Mbps connectivity is increasingly becoming insufficient to cover the connectivity needs of users and inside the US home.

Deloitte Global predicts that the number of Gigabit per second (Gbps) Internet connections will surge to 10 million by year-end, a tenfold increase, of which about 70 percent will be residential connections. Looking further ahead, analysts forecast about 600 million subscribers may be on networks that offer a Gigabit tariff as of 2020, representing most connected homes in the world.

Gbit/s Internet connection might appear frivolous, but a decade ago some commentators may have questioned the need for a touchscreen-based device capable of transmitting data at 150 Mbps, with storage for tens of thousands of HD photos, video quality sufficient for broadcast, a pixel density superior to most TV sets, a secure finger-print reader, and billions of transistors within a 64-bit eight core processor. While this prediction focuses on the near term, and the Gbps era, it is most likely that the speed race will not conclude upon reaching this speed.

Figure 1: Broadband Access by Speed and Competition



Broadband access data as of June 2016

Note that these statistics represent the minimum broadband speeds – faster broadband of up to 1 Gbps will come to represent the new normal. Therefore, there is quite a large market opportunity to offer higher speed services to both urban, suburban, and rural areas in the US. In fact, mmWave could also be deployed in complement to existing fiber deployments in case an operator wishes to serve new customers in its existing footprint but does not wish to dig for fiber in older neighborhoods.

Table 1: 2015 fixed broadband and FTTx houshold penetration rates

Category	Country (examples)	2015 houshold broadband penetration	2015 houshold FTTx penetration	FTTx CAGR (2013-2015)
Category 1 High broadband penetration & low FFTx penetration or growth	Australia	76%	7%	40%
	Canada	90%	6%	38%
	France	89%	5%	56%
	Germany	77%	1%	32%
	Russia	54%	26%	11%
	UK	88%	0.20%	–
	US	83%	10%	20%
Category 2 Low broadband penetration & high FFTx penetration or growth	Brazil	37%	2%	41%
	China	49%	37%	63%
	Vietnam	40%	20%	260%

Source: Ovum

2. 5G 101

Despite being ill defined, 5G is becoming a priority for telecom operators as it comes with the promise of unseen services as well as a broad range of new use cases and business models, ranging from enabling autonomous vehicles to smart agriculture and factories. 5G is expected to push the digitization of the economy further due to its ability to handle large volumes of data with low latency in real time.

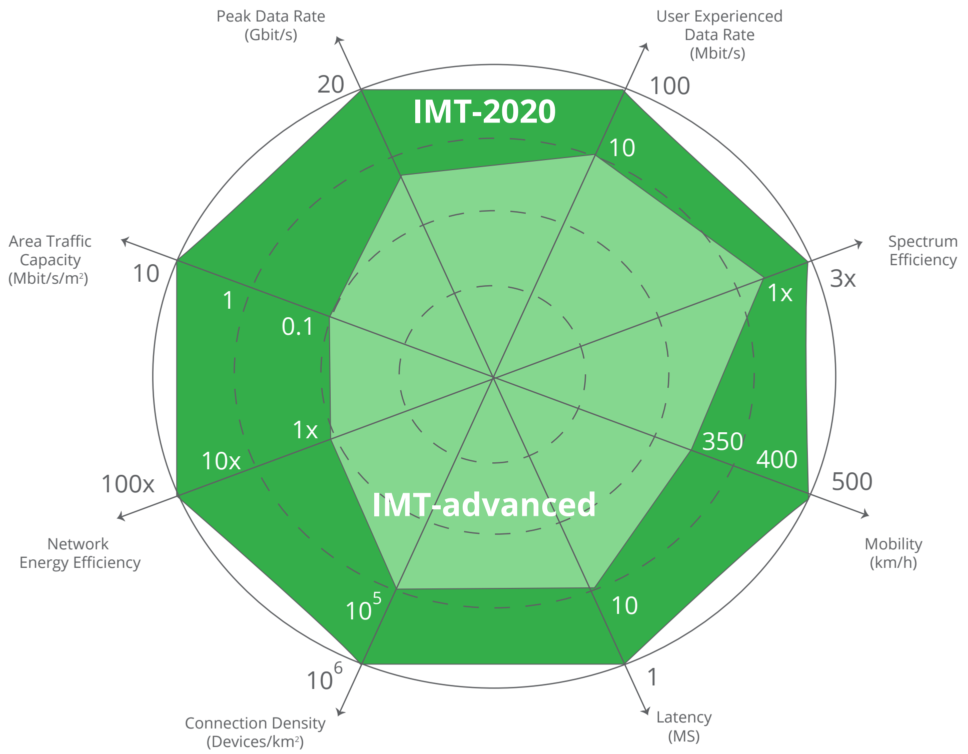
2.1 What is 5G?

The next generation of mobile telecommunications systems, IMT-2020 (commonly known as 5G), has yet to be standardized. However, much progress has already been made in developing 5G specifications. In February 2017, the International Telecommunications Union (ITU) published an early draft of what the specifications are likely to be, with the expectation that the final standard will be available by 2020[9].

Some of the key minimum technical performance requirements for 5G, as outlined in the ITU draft, are:

- A peak data rate of 20 Gbps downlink/10 Gbps uplink
- A peak spectral efficiency of 30 bps/Hz downlink and 15 bps/Hz up link
- A user experienced data rate of 100 Mbps downlink/50 Mbps uplink (in a Dense Urban test environment)

Figure 2: Comparison of key capabilities between IMT-Advanced and IMT-2020 [10]



Communication standards such as 5G must describe the frequency (or range of frequencies) at which signals are broadcast. To avoid unwanted interference, frequencies are regulated by governing bodies, such as the FCC in the U.S. This regulation can take the form of licensed spectrum, in which a user pays for exclusive use of a band; or unlicensed spectrum, in which the band is accessible to anyone (with certain restrictions). With the 5G standard yet to be finalized, a 5G frequency has not yet been determined. However, the ITU has proposed several globally viable bands in the mmWave spectrum[11]:

- 24.25 – 27.5 GHz
- 31.8 – 33.4 GHz
- 37.0 – 40.5 GHz
- 40.5 – 42.5 GHz
- 42.5 – 43.5 GHz
- 45.5 – 47.0 GHz
- 47.2 – 50.2 GHz
- 50.4 – 52.6 GHz

Table 2: Globally viable bands in the mmWave spectrum

24.25 GHz – 52.6 GHz: Licensed

3.25	24.25 – 27.5 GHz	Licensed
1.6	31.8 – 33.4 GHz	Licensed
3.5	37.0 – 40.5 GHz	Licensed
2	40.5 – 42.5 GHz	Licensed
1	42.5 – 43.5 GHz	Licensed
1.5	45.5 – 47.0 GHz	Licensed
3	47.2 – 50.2 GHz	Licensed
2.2	50.4 – 52.6 GHz	Licensed

57 GHz – 71 GHz: (Unlicensed) V-Band

7	57.0 - 64.0 GHz	(Unlicensed) V-Band
7	64.0 - 71.0 GHz	(Unlicensed) V-Band

71 GHz – 76 GHz: Lightly licensed

81 GHz – 86 GHz: Lightly licensed in the U.S. E-Band

5	71 - 76 GHz	Lightly licensed
5	81 - 86 GHz	Lightly licensed in the U.S. E-Band

The following are the bands available to wireline and cable operators at no or little cost:

- 57GHz to 64GHz plus 64GHz to 71GHz – V-Band unlicensed
- 71GHz – 76GHz; 81GHz to 86GHz lightly licensed in the US and called E-Band
- 72GHz is not part of the spectrum owned by large ISPs. It is affordable and open for all

Of these, three frequencies have emerged as leading candidates for 5G. These include the 28 GHz, 39 GHz, and 72 GHz bands, which have achieved popularity due to a concentration of research and prototyping at these frequencies.

One reason for this concentration is that these bands are owned in part by large ISPs, thus, offering a commercial incentive to utilize them in 5G networks. Mobile providers including Samsung, Verizon, Nokia, and others have built prototypes and conducted field trials utilizing these bands (especially 28 GHz). In the U.S., Verizon and AT&T plan to deploy 5G as early as 2017 ahead of the 2020 release of an official 5G standard[12]. However, those are still technology trials rather than commercial deployments since 28GHz radios are not commercially available yet. Providers from several other countries including Russia, Brazil, China, South Korea, and more also have plans to deploy pre-standard (pre-2020) 5G networks[13].

In the U.S., unlicensed mmWave frequencies available for 5G primarily cover the band from 57 – 71 GHz, called the V-Band, or 60 GHz band. This band offers 14 GHz of contiguous spectrum, which is more than all other licensed and unlicensed bands combined[7]. This makes the 60 GHz band an excellent alternative to licensed mmWave frequencies for smaller providers, as it can be used to deliver 5G performance for the minimal cost of available 60 GHz infrastructure products.

2.2 Early “5G” use cases

5G is expected to serve a large variety of use cases, made possible by the increased capacity of mmWave technology. With data speeds greatly exceeding current broadband solutions in the U.S., 5G will allow for data-intensive applications ranging from 8K video streaming to augmented and virtual reality (AR/VR). Furthermore, the reduced latency of 5G communications makes it promising for real-time control of connected machines and devices, such as factory assets, autonomous vehicles, and smart city technology (including smart street lighting, air quality sensors, and real-time traffic management). Together, networked devices of this kind are referred to as the Internet of Things (IoT), and IoT applications are poised to benefit immensely from 5G technology[14].

In addition to mobile broadband, 5G will also enable fixed wireless broadband, delivering gigabit throughput to a variety of end users without the need for costly fiber-to-the-premises (FTTP) installations. For example, single family homes in a suburban region could be serviced with a point-to-multipoint (PtMP) topology by using existing V-band products. Similarly, multiple dwelling units (MDUs) in both urban and suburban environments could be serviced with a point-to-point (PtP) topology, using the same currently available technology. Such networks are easily scalable and much quicker than fiber to deploy, yet provide the same gigabit throughput as fiber. Thus, with its fiber-like capacity, ease of deployment, and currently available solutions, 5G fixed wireless is an excellent option for the so-called “last mile” of fiber networks.

2.3 "5G" Timeline

3GPP is currently standardizing 5G in Release 15, which will complete the no standalone version of 5G in March 2018. Based on a typical minimum period of 18 months to build and deploy the technology, initial 5G NSA deployments could occur toward the end of 2019 or the beginning of 2020. 3GPP will complete the full Release 15 specifications in September 2018, enabling deployments in 2020. Release 16, which is the second phase of 5G, will be complete at the end of 2019, and Release 16 deployments could occur in 2021. In 2020, 3GPP will begin work on Release 17 which will include yet unknown capabilities.

Supporting Gigabit to the home services for every single-family home requires that the customer premises equipment (CPE) price be at the right price point (meaning, inexpensive enough). In order to meet an aggressive price point, a highly integrated chipset is a must; however, the standardized 5G chipset for CPE will be only be available in 2020 (and that might be wishful thinking). The most compelling proposition for 60GHz is that it has a full commercial Ecosystem that can deliver 5G services at the right price point – today!

User devices capable of 5G operation have not yet been announced, but availability will likely follow the trends of previous generations of networks. Initial devices, possibly in the 2019 timeframe, will likely include routers that have a 5G radio and use Wi-Fi for local Hotspot capability and USB modems. Handset vendors are in the early stages of designing mmWave support into smartphones. These devices could come online in the 2021 timeframe, although this estimate could tighten or lengthen depending on chipset availability and handset vendor plans.

We provide more details on devices in section 3.

3. mmWaves 101

3.1 mmWave Spectrum

Millimeter waves (mmWaves) refer to the range of the electromagnetic spectrum which includes wavelengths from 1 – 10 mm, corresponding to a frequency range of 30 –300 GHz. However, in the context of 5G, the term mmWave often stretches to include slightly lower frequencies (down to about 24 GHz, which corresponds to a wavelength of 12.5 mm), to incorporate all viable 5G frequency bands. 5G networks are not expected to employ mmWaves higher than 100 GHz (i.e., lower than 3 mm).

Most current wireless technology utilizes significantly longer wavelengths than mmWaves. For example, Wi-Fi and Bluetooth both employ the 2.4 GHz ISM (Industrial, Scientific, and Medical) band to broadcast signals, meaning they use wavelengths of 125 mm. Even longer wavelengths are used in AM radio broadcasting, which can utilize waves as long as 2 km.

3.2 mmWave is Fiber-Like Wireless

The relatively unexplored use of mmWave-scale wavelengths offers both advantages and disadvantages. Because this portion of the spectrum has previously gone mostly unused, there is plenty of untapped bandwidth available[14]. Additionally, mmWave frequencies allow for fiber-like wireless capacity, enabling gigabit broadband internet with a fixed wireless infrastructure. However, the high frequency of mmWaves results in a shorter signal range because of greater signal attenuation[15]. The differences between mmWaves and more commonly used spectrum necessitate novel system research and design.

Fortunately, because of its promise for 5G networks and other applications, mmWave research is well underway. In the past several years, many proof-of-concept mmWave systems have been designed and prototyped, and have demonstrated the effectiveness of mmWave systems in the field. For example, at Mobile World Congress 2015, Nokia demonstrated a bidirectional 73 GHz mmWave system prototype that achieved a peak speed of 2.3 Gbps with a range of 160 – 200 m. The next year, at Mobile World Congress 2016, Nokia presented a unidirectional 15 Gbps version of the system[14]. In addition to research of mmWave systems, mmWave technology (such as integrated circuits and antennas) has advanced to the point that wireless mmWave products can be manufactured cheaply and reliably[12 14]. For this reason, mmWaves are starting to be used in real-world applications ranging from automotive radars to touchless gesture sensors and medical imaging technologies [16].

3.3 The Case for 60 GHz Spectrum

The downside of mmWaves' promise for future 5G networks is that licensed mmWave spectrum has begun to be dominated by large ISPs, like Verizon and AT&T in the U.S. Viable 5G mmWave bands are unfairly dominated by these providers; collectively, they own 55% and 66% of the popular 28 and 39 GHz bands, respectively. In total, these two companies own 58% of licensed mmWave spectrum in the U.S. [8]. However, the good news is that unlicensed and lightly-licensed mmWave spectrum, such as the 60 GHz V-Band and 70/80 GHz E-Band, can provide the benefits of mmWaves without the prohibitive costs of licensed spectrum. This allows smaller ISPs to stay competitive amidst the monopolistic practices of larger providers.

For example, San Francisco-based Webpass, a gigabit ISP acquired by Google Fiber in 2016, is using commercially available mmWave technology to provide broadband service[17]. Webpass uses a combination of fiber networks and PtP mmWave radios to deliver gigabit broadband to residential and business customers. These radios operate in the inexpensive, lightly licensed 70/80 GHz E-Band, avoiding the licensed mmWave spectrum owned largely by Verizon and AT&T[18]. Another service provider using mmWave wireless solutions is UK-based Metronet, which also utilizes the 70/80 GHz E-Band for last mile broadband infrastructure. Like Webpass in the U.S., Metronet can deliver gigabit fiber-like wireless to U.K. customers using mmWave radios [19]. In addition to the comparatively low cost of fiber-like wireless infrastructure (as opposed to FTTH), a further advantage of mmWave fixed gigabit wireless networks is the ease of deployment and scaling. Networks of this kind, utilizing the lightly licensed 70/80 GHz E-band or unlicensed 60 GHz V-Band for last mile wireless broadband, are an affordable and appealing option for many wireline and cable service providers.

Of these, the 60 GHz V-Band is a particularly appealing option for FWA service providers. Unlike the lightly licensed 70/80 GHz E-Band, the 60 GHz band is unlicensed, and therefore, is accessible to a wider range of providers. Additionally, the 14 GHz of contiguous spectrum in this band offers more bandwidth than any other licensed or unlicensed mmWave band. Further, the 60 GHz band has chipsets and technology currently available on the commercial market. In order to deliver gigabit-to-the-home (GTTH) service, it will be necessary to achieve the right price point for customer-premises equipment (CPE). Thus, the most compelling case for the 60 GHz band is that it uniquely achieves this CPE price point with a full ecosystem of commercial technology - other mmWave bands do not yet have standardized chipsets available.

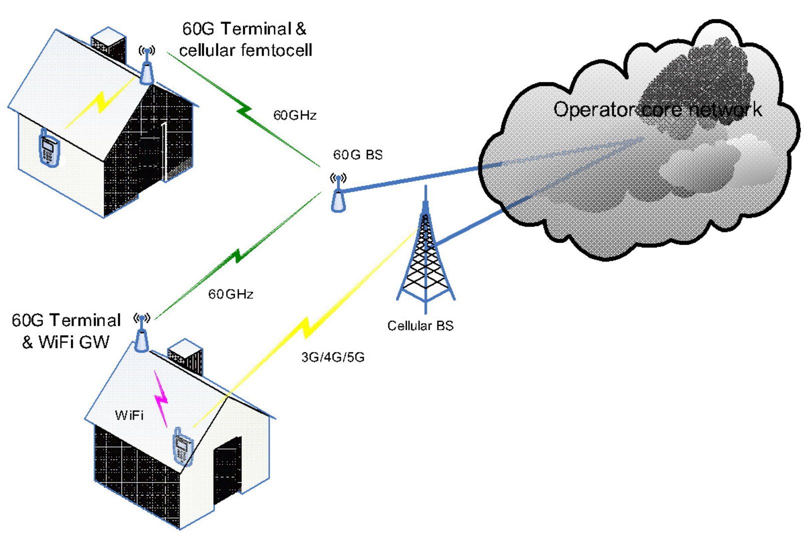
In Table 3, the properties of 60 GHz are contrasted with those of the 28 and 39 GHz licensed bands.

Table 3: Advantages of the 60 GHz band

Band (GHz)	28	39	60
Bandwidth (MHz)	1,200	3,500	14,000
Standard	5G (3GPP)	?	WiGig
Capacity (Gbps)	→ 2	→ 1	2 → 8
Range (m)	~1,000	~1,000	~400
Chipset	2018 (?)	2018 (???)	Now
Products generally available	2020 (?)	2020 (???)	Now

Another advantage of the 60 GHz band is that it readily complements 3G/4G/5G mobile technology, and can share infrastructure with other technologies. This is illustrated in Figure 3.

Figure 3: Shared infrastructure - 60 GHz and mobile technologies



4. 5G Broadband Fixed Wireless Access (FWA)

4.1. The Case for pre-standard 5G Technology

Deploying 5G FWA gives wireline operators a head- start in working with different aspects of 5G as a practical alternative to FTTH/FTTP. Operators can become familiar with a new air interface, new spectrum, new radio form factors, and new antenna systems. An early experience in those aspects of the 5G technology can help speed up full 5G deployments once the standards are set.

Other benefits for wireline operators to test and deploy earlier version of 5G technologies is that it will allow them to exercise a more notable influence on the standard developments. MNOs will be able to reuse some of their FWA deployments to support their wireline operations. These deployments can readily take the form of hybrid fiber wireless, in which only the last mile of a network is wireless.

4.2. Early 5G Trials

One immediately accessible benefit of 5G and mmWave research is the commercial availability of mmWave solutions, such as PtP radios, which can be used to provide fixed wireless access (FWA) for gigabit broadband service. Before describing this benefit further, it is helpful to appreciate the large quantity of early 5G experiments that have helped advance mmWave technology to its current state. Table 4 presents a non-exhaustive list of both past and planned 5G research and field trials, utilizing both licensed and unlicensed mmWave spectrum.

Table 4 - A list of early 5G research, trials, and demonstrations

Year	Organization	Description
2011 – 2013	NYU Wireless	Extensive propagation measurement campaigns were conducted to develop channel models at mmWave bands including 28 GHz, 38 GHz, 60 GHz, and 73 GHz [20] [21]
2014	Nokia	Used the NYU Wireless channel measurements to research and demonstrate a 73 GHz over-the-air link [22]
2015	Nokia	At Mobile World Congress, demonstrated a 73 GHz mmWave system that achieved a peak data rate of 2.3 Gbps [14] [22]
2015	Samsung	Expanded upon earlier channel measurements to demonstrate the viability of 28 GHz for cellular communications, and began researching phased arrays for cell phones [22]
2015	Qualcomm	Conducted 28 GHz experiments in a dense urban environment to show the capacity of intelligent beamforming for Non-Line-of-Sight (NLoS) communications [23]
2016	Huawei/Deutsche Telekom	Presented a 73 GHz prototype mmWave system that used multi-user multiple-input-multiple-output (MU-MIMO) to achieve the potential for greater than 20 Gbps throughput [22]
2016	AT&T/Ericsson/Intel	Tested enterprise 5G applications using mmWave bands of 15 GHz and 28 GHz, achieving over 1 Gbps in a field trial at an Intel office [24]
2016	Nokia	At Mobile World Congress, demonstrated a 73 GHz mmWave system that achieved a data rate of 15 Gbps [14]
2016	Nokia	At Brooklyn 5G Summit, demonstrated beam scanning with a phased array for a 60 GHz system with 1 GHz of bandwidth [14]
2017	PHAZR	Conducting U.K. and U.S. trials of a hybrid 5G broadband FWA system that uses mmWave downlink (in 24 – 40 GHz licensed bands) combined with sub-6 GHz spectrum uplink [25]
2017	Siklu	Launched the MultiHaul series of plug-and-play mmWave PtMP radios operating in the unlicensed 60 GHz V-band [26]
2017	Intel	At Mobile World Congress, demonstrated a 28 GHz Radio Frequency Front-End (RFFE) 5G Mobile Trial Platform capable of up to 3 Gbps Over-The-Air (OTA) data transfer [27]
2017	SK Telekom	Plans to deploy a pre-5G network in South Korea by the end of 2017 [13]
2017	Verizon/AT&T	Both providers plan to deploy pre-standard 5G systems in the U.S. [22]

The success of these and other trials have clearly demonstrated the potential of 5G mmWave technology for both mobile and fixed broadband services. In particular, small service providers can utilize unlicensed mmWave bands (such as the 60 GHz V-Band) to provide 5G FWA with fiber-like, gigabit throughput. Not only are commercial products available to deploy 5G FWA, but providers such as Webpass in the U.S. are currently operating with this exact model [18].

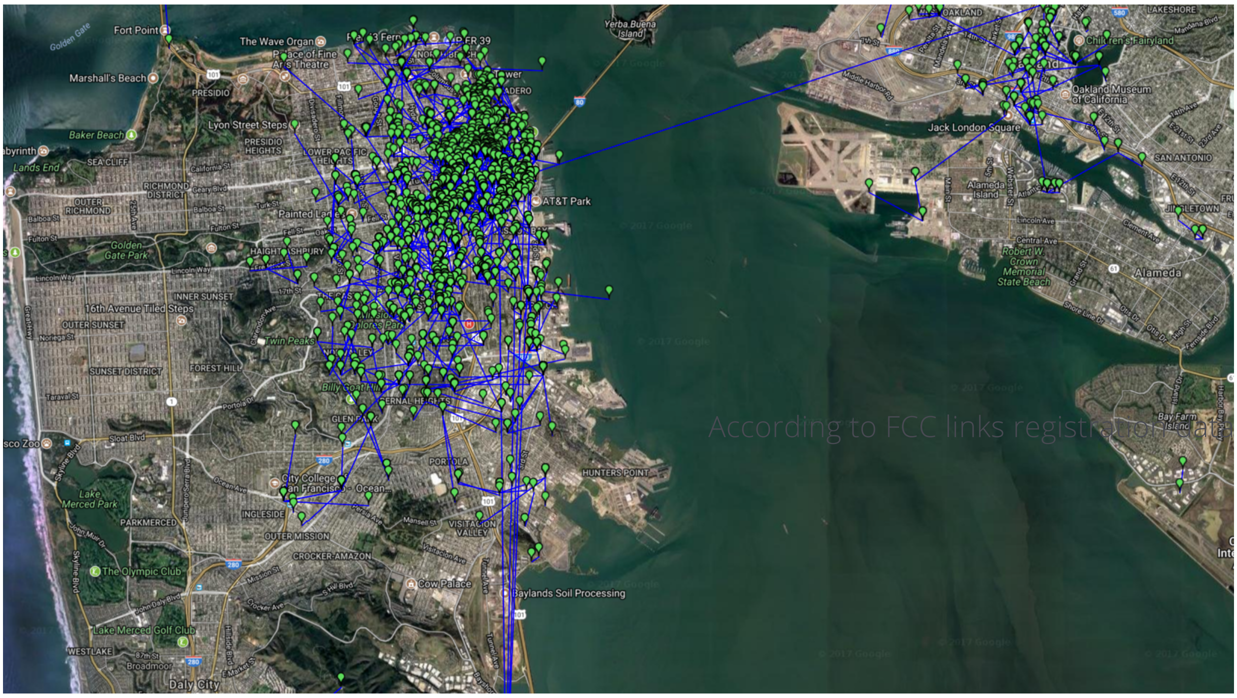
4.3. Short Term planned RFIs and Deployments

RFI/P we are aware of at least 2 RFP for pre 5G mmWave FWA solution issues by two tier 2 Wireline carriers (We cannot disclose names since we are under NDA). Currently it is in the lab and field testing phase.

However smaller regional innovative ISP already use mmWave PTP and ramping up PtMP to deliver Gig services in large scale.

4.4. Delivering the Promise

Figure 4: Deployed Active Systems in San Francisco



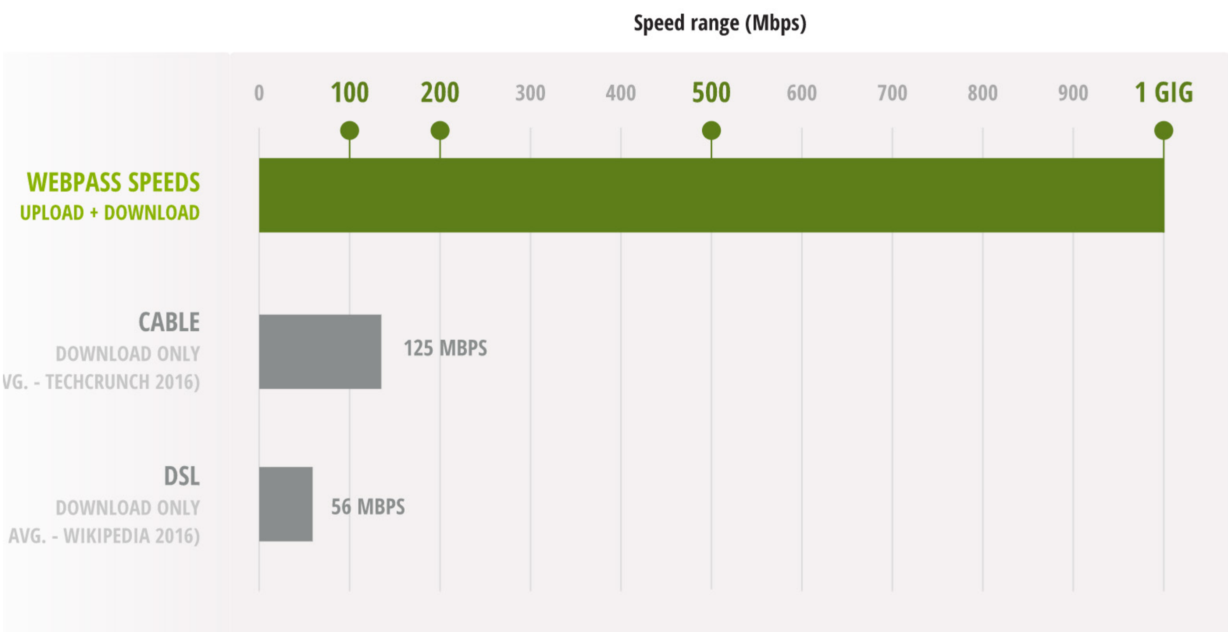
60/70/80GHz wireless systems are a reality today. This map from the interactive FCC database shows the massive number of deployed systems active today in San Francisco. A similar map can be generated for cities all over the US and UK.

Webpass is a high-profile example of early 5G deployments focused on providing fixed wireless used to complement fiber networks without the need to run fiber all the way to the home.

About WebPass

Webpass, which was acquired by Google in 2016, uses point-to-point wireless technology to connect businesses and multi-unit residential buildings in densely populated areas. Webpass strategy is to use wireless in complement to fiber deployments where it makes more sense to deploy wireless mmWave. Webpass's residential service offers speeds of up to 1Gbps for $60 a month including in San Francisco, Denver, Seattle, San Diego, Miami, Chicago, and Boston. Webpass claims more than 25,000 active customers and over 1,000 buildings connected.

Figure 5: Speed range(Mbps) comparison



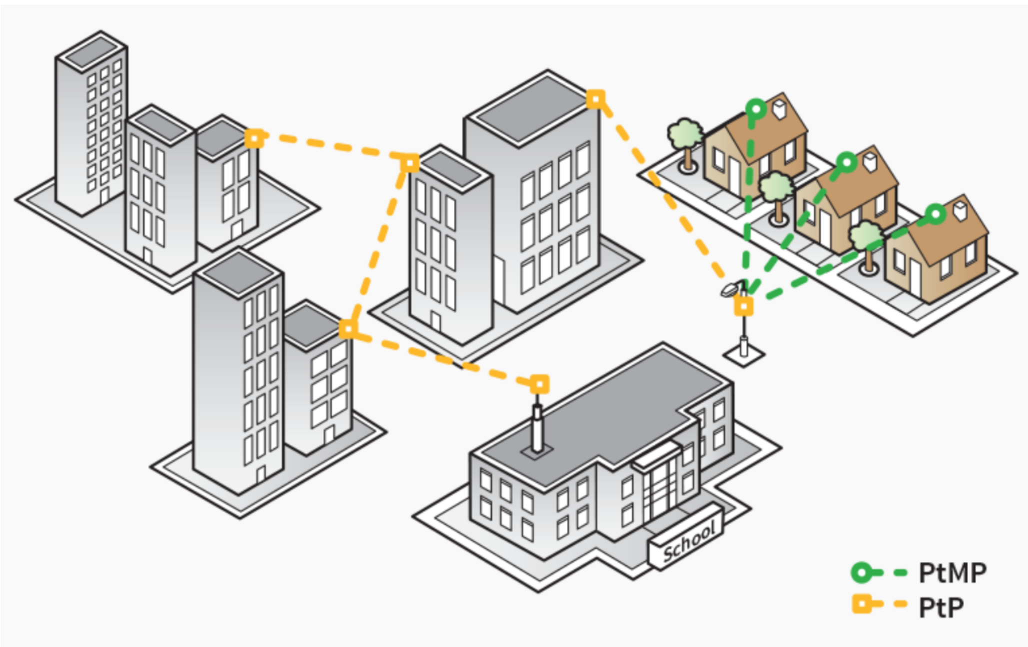
5. The Business Case for 5G FWA

5.1. Network Architecture

To better understand 5G FWA, an overview of the network architecture is warranted. 5G FWA is well-suited to serve as an alternative to expensive and slow FTTH deployments, specifically in the so-called last mile (i.e., the final infrastructure connection to homes, MDUs, or businesses). Instead of deploying fiber directly to the premises (FTTP), the last mile can instead be replaced with fiber-like wireless networks. By using high capacity mmWave technologies for these networks, the gigabit throughput of fiber can be maintained despite the lack of a physical fiber connection.

5G FWA can be provided using either point-to-point (PtP) or point-to-multi-point (PtMP) topologies. In the case of PtP, a base station or other network node communicates with a single other node; in PtMP, a base station can communicate with multiple end nodes. To realize either of these topologies with mmWaves, a technique called beamforming is often employed. Beamforming provides a method of directing wireless signals to require the least amount of transmit power possible, by manipulating several non-directional antennas to simulate a large directional antenna. Arrays of antennas used for this purpose are known as phased arrays. In practice, there are many methods of beamforming, including analog, digital, and hybrid architectures. However, these methods employ the same principles of constructive and destructive wave interference to focus signals in the direction of choice [28].

Figure 6: IllustraDon of PtMP and PtP wireless topologies



Beamforming for PtMP mmWave signals is especially important because of the high attenuation experienced by high frequency signals as they propagate. For both licensed and unlicensed mmWave bands, a combination of beamforming and short ranges (up to about 400 m) can overcome these poor propagation characteristics, even in dense urban non-line-of-sight (NLoS) environments. Increasing the number of beamforming antennas in a phased array can provide extended ranges (up to 3 miles) for high-frequency mmWave signals. However, the comparatively short range of mmWave signals can nevertheless provide full area coverage when combined with the expected densification of 5G networks. Densification refers to the number of base stations per square kilometer, which for 5G may reach a density of 40 – 50 base stations, obviating the necessity for long wireless ranges [15]. For these reasons, the best way to achieve 1 Gbps service coverage using FWA is by densifying the network and utilizing 60 GHz mmWave, which has 14 GHz of available spectrum.

With these building blocks in place, it is clear how 5G FWA can be provided to single family homes, MDUs, or businesses in urban or suburban environments. Rather than extending a fiber network directly to premises, a mmWave PtP or PtMP radio base station can be used to set up fiber-like wireless connections to each unit in the service area having the appropriate customer-premises equipment (CPE).

In the U.S., 5G FWA has emerged as the first real offering of commercial 5G services, in part because of the comparative lack of complexity compared to mobile 5G [29]. This is exemplified by Google Fiber's loss of momentum as the expense and time required for fiber deployments began to prove impractical, followed by the company's purchase of Webpass, a service provider employing a fiber-like wireless approach to last mile network infrastructure[17]. Other providers in the U.S., such as PHAZR, are poised to begin offering 5G FWA as early as this year. Currently, 5G FWA is not possible with mmWave bands such as 28 and 39 GHz, because commercial chipsets are only available for the 60 GHz band. 5G over mmWave is a promise, but 5G over 60 GHz is a reality.

For fixed broadband service providers, there are several clear advantages to a 5G FWA approach. To begin, fiber-like wireless is both cheaper and easier to deploy than FTTH. These advantages beget further advantages, in that fiber-like wireless can be deployed more quickly than fiber, and scaled more easily. Without having to spend the massive upfront investment of FTTP infrastructure, service providers can cover a service area with the minimal infrastructure cost of mmWave base stations and CPE. An additional benefit of this paradigm is that no investment is wasted in connecting customers who won't sign up for broadband services [29].

Of course, these advantages would be frivolous if 5G FWA could not meet the growing consumer need for fast and reliable broadband access articulated by the FCC [1]. As we've seen, mmWave technology is perfectly capable of matching the gigabit throughput of FTTH connections. This has been clearly demonstrated (see Table 1) for both licensed and unlicensed mmWave bands. Additionally, with intelligent beamforming solutions, pencil-thin mmWave beams can be broadcast to minimize interference and provide strong wireless reliability. Finally, the availability of commercial mmWave PtP and PtMP radios that can achieve these required properties (gigabit throughput and strong reliability) at unlicensed or lightly-licensed mmWave bands (the 60 GHz V-Band and/or 70/80 GHz E-Band) makes 5G FWA a viable service option for all service providers[26].

5G FWA is suitable for businesses, multiple dwelling units (MDUs), gated communities, and single-family homes, ideally for residential densities of around 1,000 households per square mile [29]. With the ease of 5G FWA deployment, area coverage can be extended quickly and the number of broadband subscribers can be easily scaled. For broadband customers, the combination of quick access (no waiting for fiber installations) and reliable, gigabit speeds is an appealing incentive to switch from larger providers, who dominate the market while offering poor service. And for the millions of Americans who have no broadband access at all, 5G FWA is perhaps the best option for providing broadband coverage.

As 5G becomes standardized and mmWave technology matures, there will undoubtedly be new broadband solutions that arise. However, just as FTTH solutions will continue to exist alongside 5G FWA, so too will 5G FWA exist alongside whatever new solutions enter the market. As long as 5G FWA continues to provide reliable, gigabit broadband, it will continue to serve broadband customers. In fact, with peak 5G adoption predicted to occur around 2040 [15], it's a safe bet that 5G FWA solutions will endure for at least the next couple of decades. Together, the flexibility, scalability, and survivability of 5G FWA make a strong case for service providers to invest in this growing technology. This being the case, small providers should not wait for mmWave technologies for the 28 and 39 GHz band to mature, considering the commercial availability of 60 GHz chipsets. By waiting until these other mmWave bands mature, small providers will be unable to afford the licensing of their spectrum, and will lose the 5G battle to larger providers.

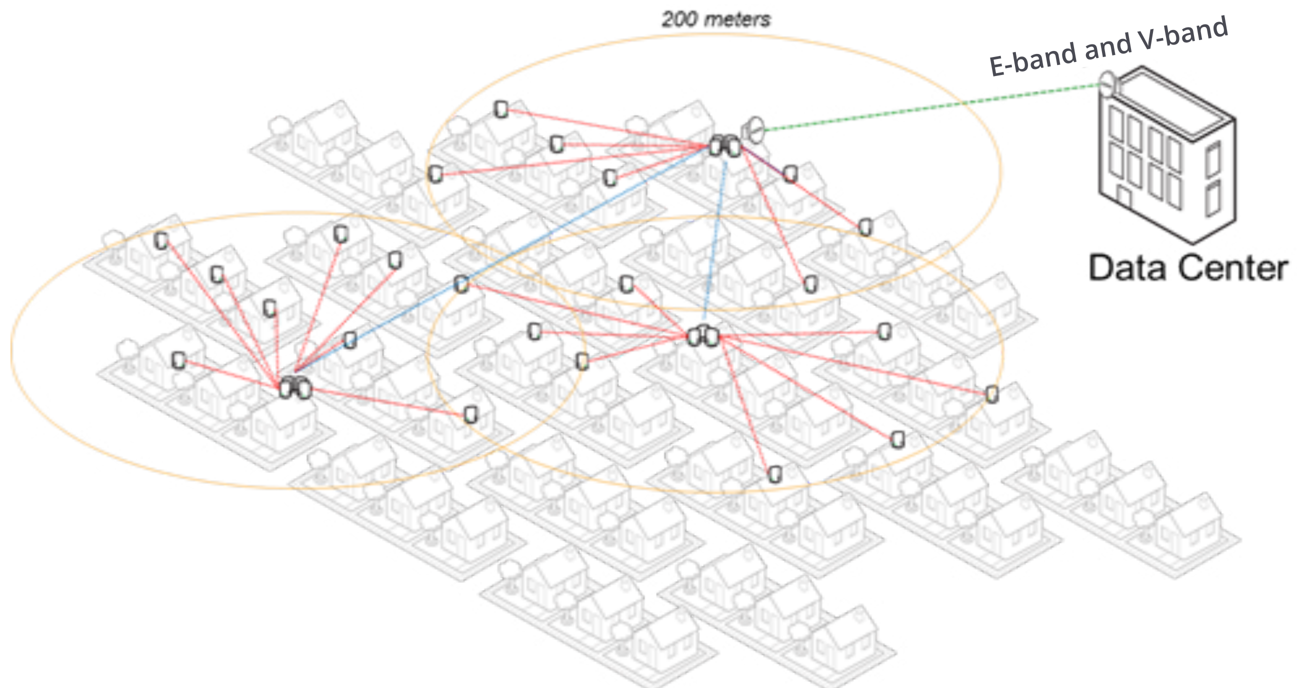
5.2. Business case Scenarios & KPIs

We know that deploying wirelessly is much faster than deploying any wireline technology including fiber. But how does mmWave compare to fiber in terms of cost when serving the same customers with the same levels of services?

We ran some cost analysis for both technologies in 2 scenarios, single family unit and multi-dwelling and assuming the most possible generous conditions for the use of fiber to make an honest and fair comparison.

5.2.1. Single Family Unit (SFU)

Figure 7: Illustration of FWA deployment in a Single family home neighborhood



In this scenario, we compare the cost of a single-family home passed (no drop) as well as connected (with drop) using mmWave vs fiber technology. We assumed a deployment covering 82 single family units in a suburban environment as illustrated in the picture above.

Our assumptions include for the mmWave solution, using 5 hubs with 4 sectors each resulting in a total of 20 base station units (BUs) and 77 terminal units (TUs) since each hub also serves as a TU for the corresponding SFU where it is mounted. We also assume the use of 2 E-band as well as 4 V-band backhaul links back to the data center. The equipment including cabling for the hubs amounts to $23,145 to which we added $1,500 in labor costs and arrive at a cost of $301 per SFU passed (no drop).

When we add the cost of the drop for the additional 77 TUs with the equipment (including mast and cabling, power supply mounting kit) and labor costs, the analysis results in cost of $500 per SFU dropped which adds to the $301 per SFU for the passing/distribution portion.

Adding both figures, we derive a total cost of $801 per connected (passed and dropped) SFU using mmWave technology.

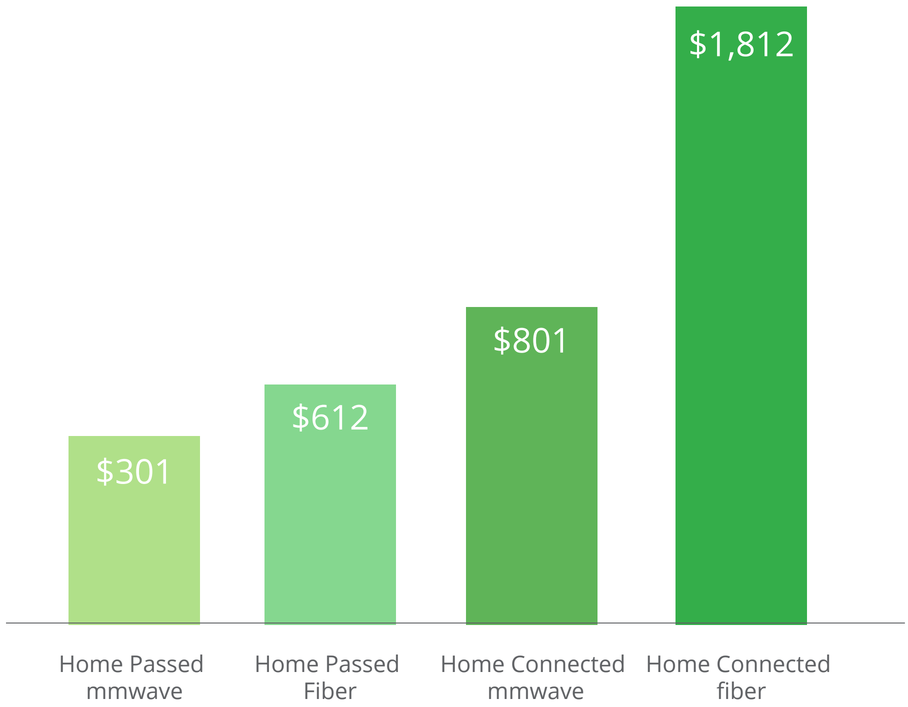
We now turn to the scenario of using aerial fiber and assuming the most possible generous conditions for the use of fiber to make an honest and fair comparison for a similar service delivery.

To cover those 82 homes, 4103 feet of fiber are needed along with 34 terminations (4 ports) and NAP (4ports) poles. We assumed the fiber is make-ready and no splicing is required. Those assumptions result in $19,506 equipment cost then we add $30,716 in labor costs which includes: fiber distribution, termination and NAP labor using industry average figures.

In this scenario, the cost per home passed is $612 with no drop. The drop equipment consisting of a NAP to terminal and ONT amounts to $17,384 for the total 82 homes dropped, on top of which we need to sum the NAP to terminal labor cost of $30,750 resulting in $1,200 per home dropped.

Thus, when we add the cost of distribution and drop, the results are $1,812 per home connected (passed and dropped) with fiber. That is over $1,000 more than the cost of connecting a SFU with mmWave and not considering speed of deployment which is must faster with mmWave.

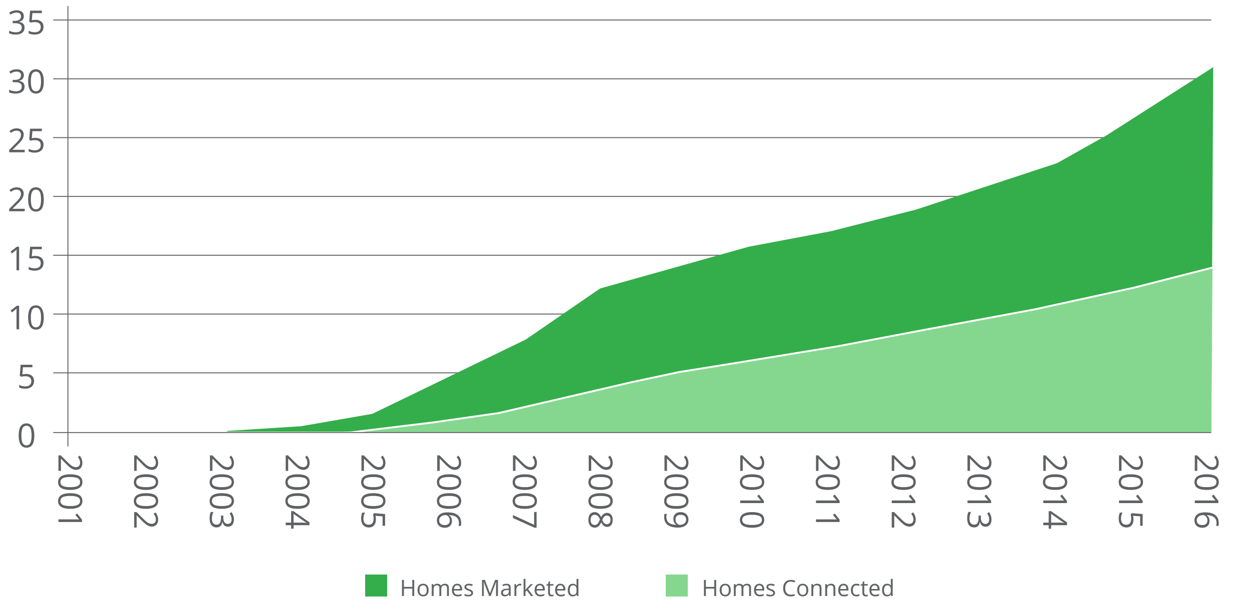
Graph 1: The Cost per Home for Distribution and Drop by Technology



As the fiber chart above clearly indicates, the additional cost of the drop for fiber is what makes fiber prohibitive for carriers compared to wireless. It also illustrates that when fiber pass is combined with wireless drop, the business case can become quite viable since the cost of a home passed with fiber remains well below the cost of the home connected with mmWave - this leaves a margin to drop with mmWave under reasonable costs and time to deploy.

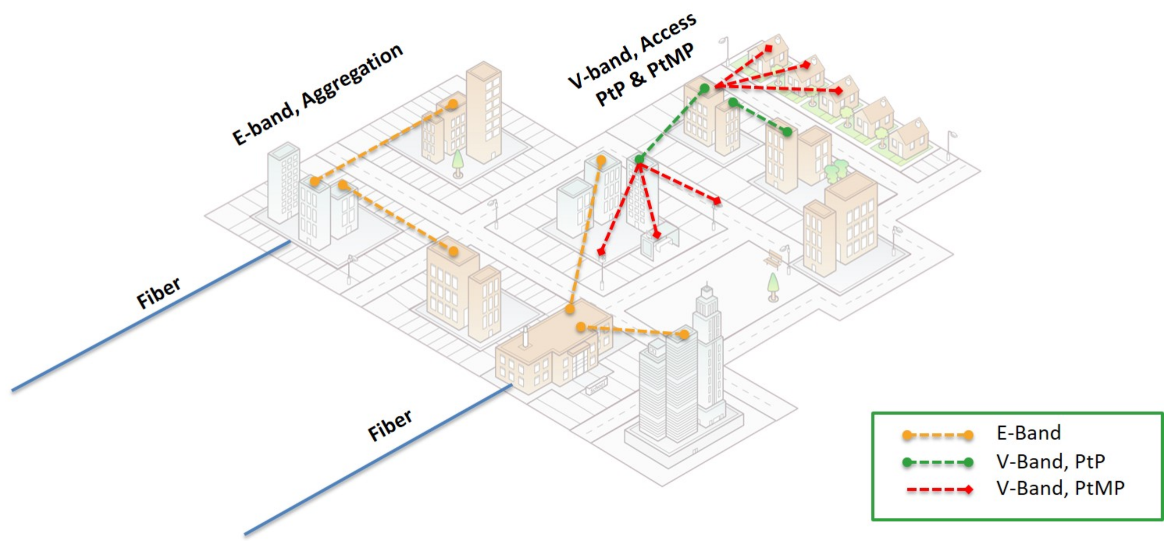
It also explains why the level of homes connected with fiber is lagging well behind the number of homes passed/marketed (not dropped) and represents a great market opportunity for carriers to fill in the gap with mmWave drop. True FTTH Now Passes Over 30 Million Homes in the U.S.

Graph 2: FTTH Now Passes Over 30 Million Homes in the U.S



5.2.2 Multi Dwelling Unit (MDU)

Figure 8: Hybrid Fiber Wireless Connectivity for MDUs



In the case of a multi-dwelling scenario, the difference with the single unit is that we need to add the cost of in-building distribution for connecting each apartment with G. Fast, Coax, Ethernet or Wi-Fi. However, the cost of passing the units will be shared among many and will therefore be much lower than in the SFU scenario.

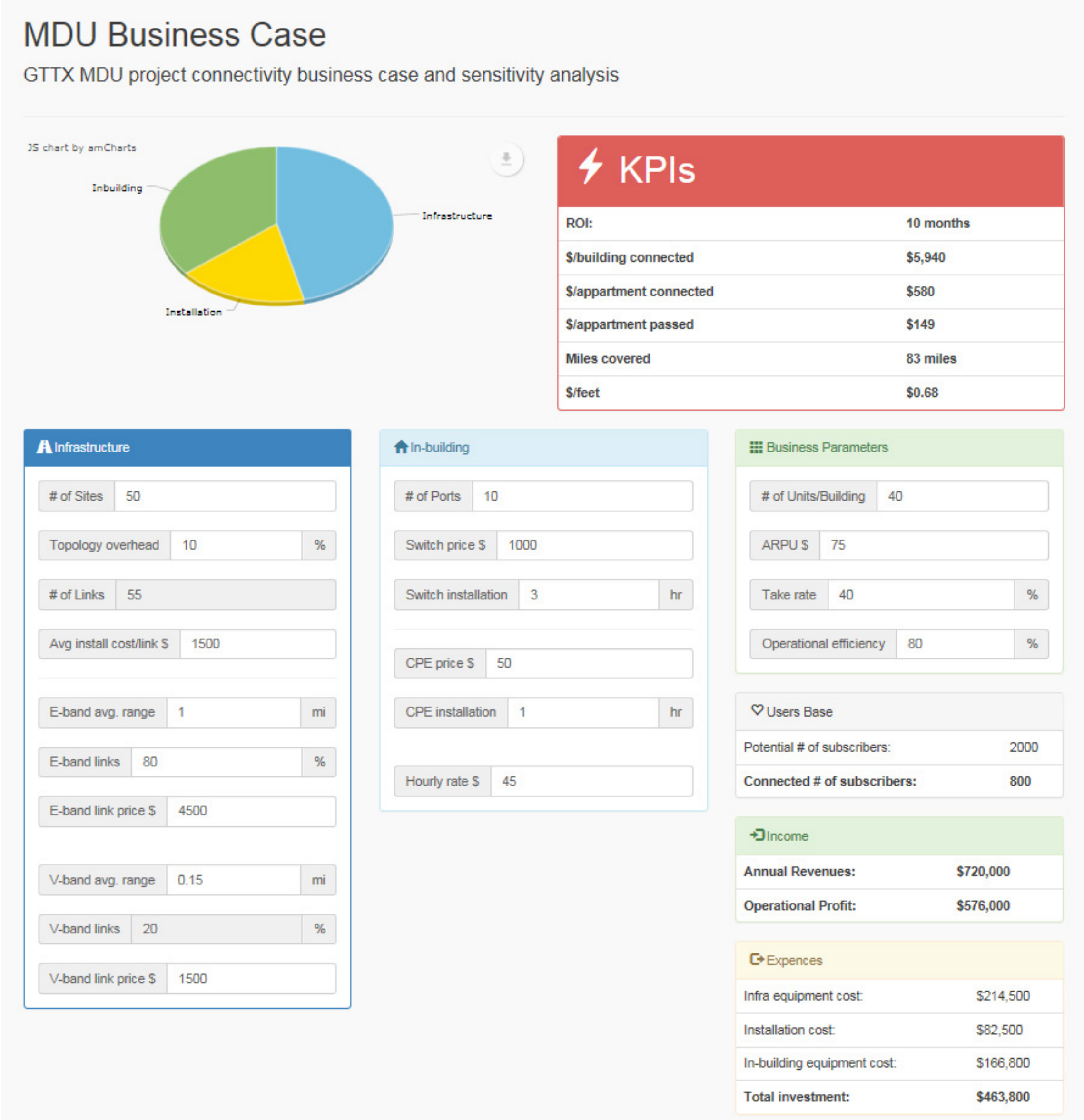
mmWave Analysis:

We assume we are providing service to 50 buildings which have either 20 or 40 units each, so either 1,000 or 2,000 units in total with a take rate of 40% which translates to eventually 400 or 800 units connected (passed and dropped). As we will see, the less units there are in a MDU, the higher the proportion of the total deployment cost is made of the infrastructure portion since there are less units to connect with inbuilding distribution. In this case, the mmWave option becomes even more attractive than fiber. In this scenario, we will need 55 point-to-point links to provide resilient topology without a single point of failure, 80% of which will be E-band and 20% V-band.

As shown in the figure below, our model indicates a total equipment cost of $214,500 and an associated installation cost of US $82,500 for a total cost of $297,000 to connect all the buildings, excluding in-building distribution. That number translates to $5,940 per building connected with mmWave. Assuming a 40% take up rate, there will be 16 units connected in each 40-unit building which results in a cost per unit connected (passed and dropped) of $580 or $951 if the building has only 20 units (with 8 connected at 40% take rate).

Please note that we assume the cost of in-building distribution is the same whether the building is connected with fiber or mmWave.

Figure 9: MDU Business Case Calculation



Source: Siklu GUI Business Model

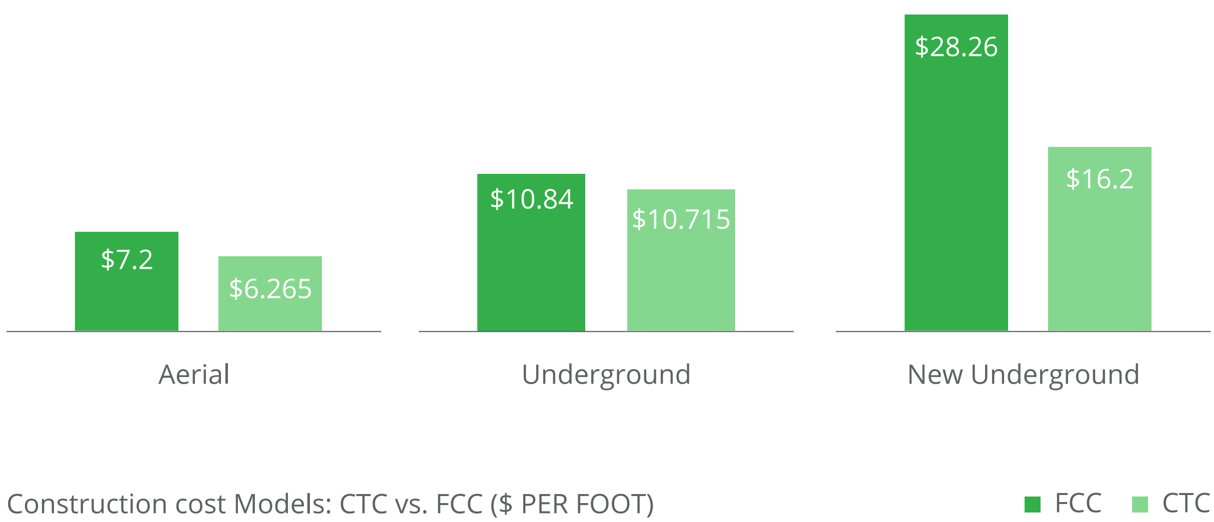
MDUs present an opportunity and a potential risk for GTTH providers. On the one hand, each MDU represents a large potential demand for services. MDUs represent about 30% of the total residential market for GTTH. But on the other, MDUs are difficult and complex to reach with fiber. More than 83% of MDUs were built before 2000 and more than 50% were built before 1980. That means providers are dealing with infrastructure that predates the internet, not just fiber. And each MDU is different, ranging from small row houses to larger, high-rise buildings with more than 100 units. So GTTH providers need to be able to handle the challenges of getting permission to enter each building or unit to install a technology, and then deal with the physical challenges of getting the fiber dropped.

Fiber Analysis

In urban and suburban areas, buildings or neighborhoods can typically access the fiber network from the closest network point. A typical fiber nod e is located between a half a mile to two miles from residential premises. Metropolitan areas typically host a variety of densification levels -- from extremely densified downtown areas to less dense residential area and suburbs.

The average cost to construct 'last mile' fiber is typically more expensive in densified metropolitan areas since labor costs for construction are higher, which increases the cost per foot to deploy. In less dense, suburban areas the distances between premises are typically larger, increasing the costs of materials. We used data that is averaged and adjusted between these different environments.

Graph 3: Construction cost Models



Construction cost Models: CTC vs. FCC ($ PER FOOT)

The above table represents 'last mile' cost analyses for the three types of fiber deployments in urban areas. Aerial and underground construction typically include a variety of parameters. The costs for each parameter may vary widely based on local environment and existing utilities.

In this scenario, we assume an average distance of .5 mile from the fiber point of presence. The cost for underground fiber in existing deployment (existing conduit etc.) according to CTC/FCC construction model is around $10/foot including labor.

So just the fiber cost in dense environment is about $26,400 (26 40 feet * $10/foot). New fiber deployed would cost at least 50% more ($16-18 $/foot). In some major cities, the cost to deploy fiber maybe up to 10x times higher than that - $300K!

Therefore, the cost for deploying fiber to the building at 0.5 mile will vary in the best case from $26,400 to $300,000 compared to $5,940 with mmWave!

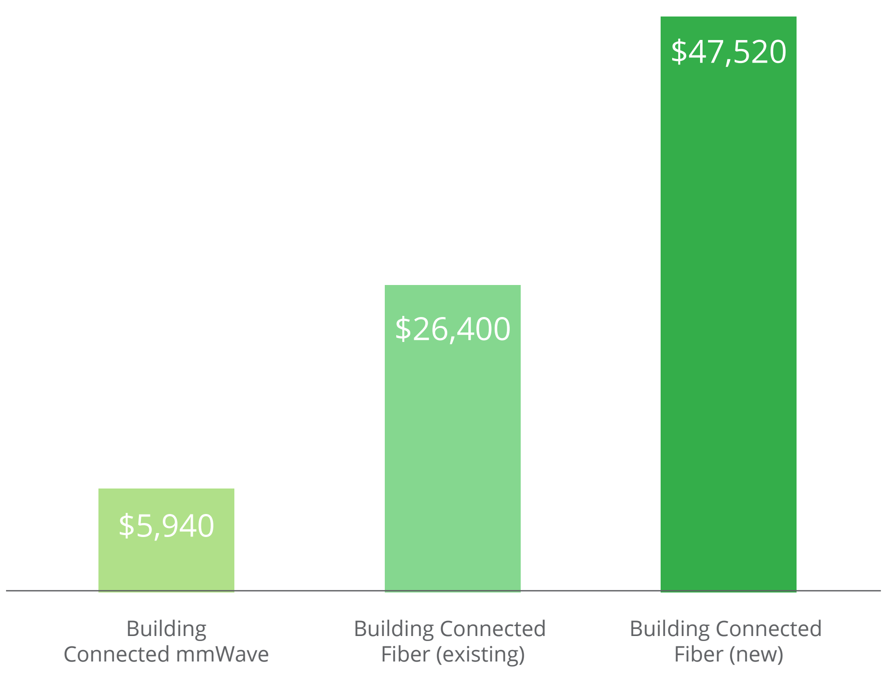
The calculations for a fiber deployment are presented below:

Table 5: Fiber Deployment Calculations

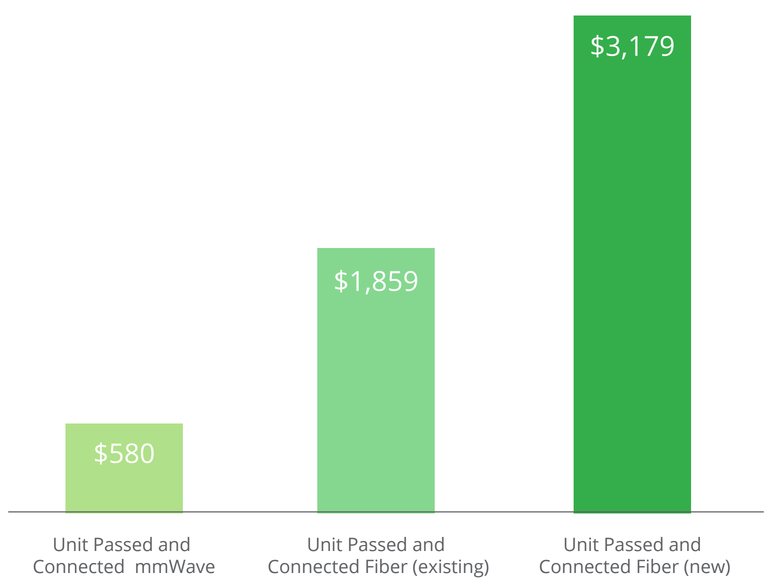
40 units per building	
units passed	40
Building Connected Fiber (existing)	$26,400
Building Connected Fiber (new)	$47,520
Unit passed and connected (existing fiber)	$1,859
Unit passed and connected (new fiber)	$3,179
In-Building Distribution (per building)	$3,336

20 units per building	
units passed	20
Building Connected Fiber (existing)	$26,400
Building Connected Fiber (new)	$47,520
Unit passed and connected (existing fiber)	$3,509
Unit passed and connected (new fiber)	$6,149
In-Building Distribution (per building)	$1,668

Graph 4: Cost of connecting an MDU Building by Technology



Graph 5: Cost of Connecting an MDU unit by Technology



5.2.3. Hybrid Fiber Wireless Proposition

Today, while FTTH projects are the favorite solution for gigabit service delivery, the timeline for these projects include a long period of network planning and design (~1 year) and even longer deployment periods (~2 years). This puts a network builder in a high-risk situation where it can only hope competition does not push prices down. And a network provider can only begin returning the investment when the last strand of fiber is deployed to the premises.

To realize infrastructure projects with high risk, a network provider may secure both a contracted subscriber base and a gigabit service much earlier using fiber-like wireless as a last mile connection technology. Fiber-like wireless installation takes less than a day. If planning and design is included, it may take anywhere from several weeks to a couple months to connect a building and begin collecting revenue to the gigabit service. So, instead of being forced to wait to deploy a gigabit while negotiations over pole attachment agreements and make-ready is in process, using fiber-like wireless, the entire construction timeline is dramatically accelerated.

Hybrid Fiber-Wireless (HFW) is a disruptive model for providing GTTH built on proven technology. This model adds high frequency wireless radios to a fiber network, drastically reducing deployment costs, time to install and possess the potential to provide multiple gigabits directly to the consumer. Simply put: by using HFW, providers can deploy a gigabit first and far cheaper than competitors. Using an HFW connectivity model in a residential market would result in a quantum leap in profitability.

About the Author

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About Maravedis

Maravedis is a premier wireless infrastructure analyst firm. Maravedis focus on broadband wireless technologies (including 5G, LTE, Wi-Fi, Small Cells) as well as industry spectrum regulations and operator trends. Since 2002, clients have been able to access Maravedis technology, spectrum and market intelligence through research services which include disruptive reports, webinars, online databases, analyst support and briefings as well as custom consulting engagements.

About the Sponsor

Siklu delivers multi-gigabit fiber-like wireless connectivity in urban, suburban and rural areas. Operating in the millimeter wave bands, its wireless solutions are used by leading service providers and system integrators to provide gigabit services, 5G fixed wireless and in safe city and smart city projects. Thousands of carrier-grade systems are delivering interference-free performance world-wide. Easily installed on street-fixtures or rooftops, the price-competitive radios have proved to be ideal for networks requiring fast and simple deployment of secure, fiber-like and future-proof connectivity. www.siklu.com.

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